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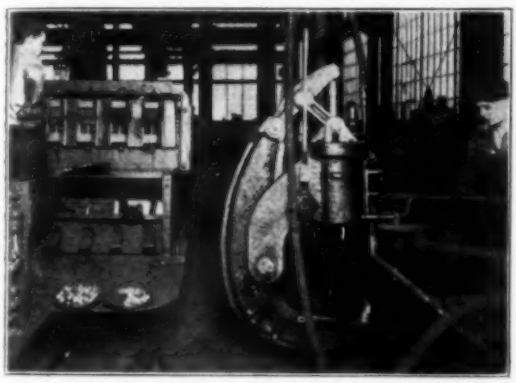
Castings Aid in Fabrication and Building Construction

HAVE you ever watched the construction of large buildings and bridges, which involve the use of many tons of fabricated steel, and wondered how many rivets were contained in the frame? To the onlooker there are millions. What an enormous amount of work must be necessary in fitting these pieces together in the fabricating operation. It is gratifying to know that castings play a large part in making these operations possible and in



Some Riveting Machines Are Capable of Driving 700 Rivets Per Hour

reducing the necessary manual labor. Riveting machines used in that class of construction are of many types including the pinch bug, yoke, bull and punch. The accompanying illustration shows a pinch bug type riveter in operation in a fabricating shop. While it is a pneumatic driven machine, hydraulic riveters also are manufactured. Castings are used in many parts of these machines including the main frame and the main lever. To illustrate the conditions that these castings must withstand, yoke type riveters are constructed capable of exerting 150 tons pressure on the rivet with an air pressure of 100 pounds. Some types of riveters drive seven hundred ¾-inch rivets per hour in fabricating steel columns. One maker recently reduced the weight of his machines by 40 per cent with the use of a truss type frame of alloy steel castings.

Find Where Castings Can Be Sold

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Gas-fired Horizontal Oven B

By Edwin Bremer

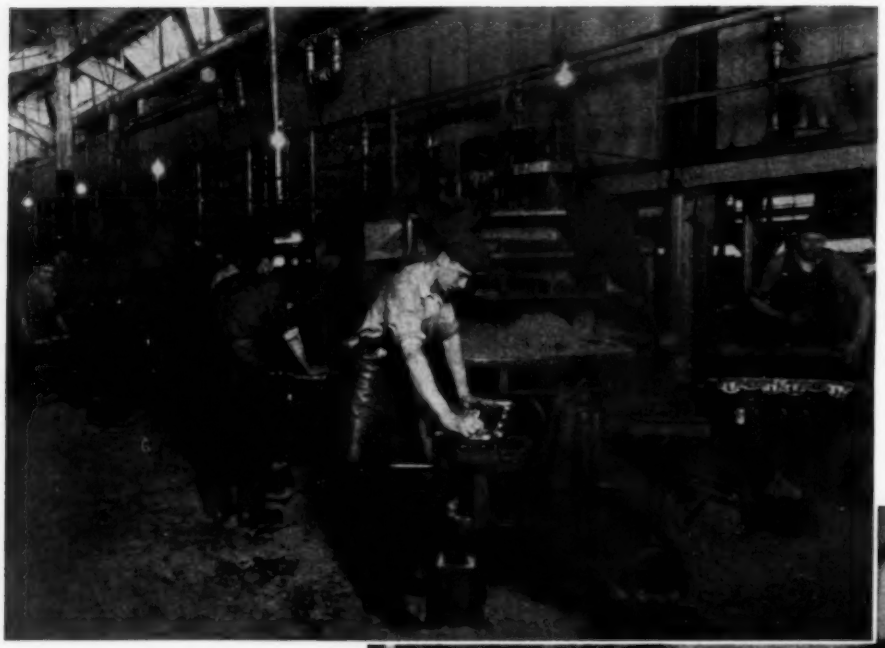
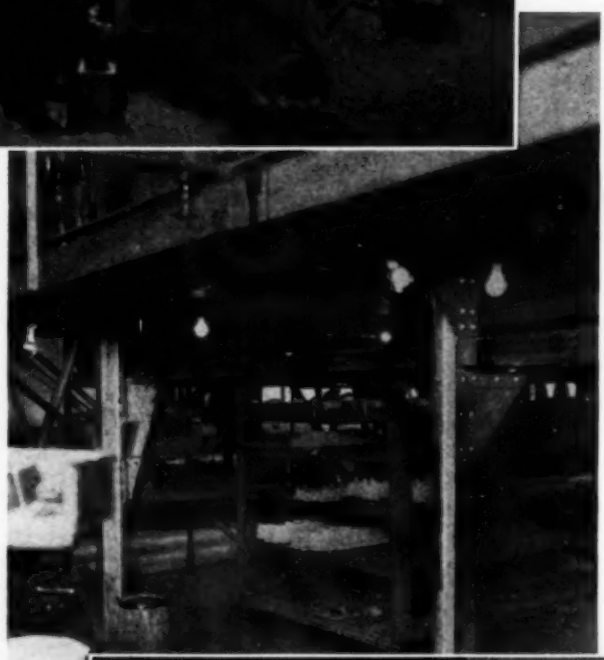


Fig. 1—Core Machines Are Close to the Oven

AS THE demand for automobiles increased, producers of that commodity discovered that methods previously used in supplying the necessary parts and assembling them into a finished product had many drawbacks. These included an oversupply of parts at one time and a lack at another. Due to the system of assembling an automobile in one spot by bringing all materials to that place on small trucks, etc., considerable difficulty was encountered in maintaining a production schedule. Another disadvantage of that method of assembly resulted from the fact that one crew of men, skilled in all assembly operations, worked upon one car until it was finished. Consequently, at various times part of the crew was idle waiting either for a necessary part to be supplied, or for the remainder of the crew to finish operations.

Study of the system in vogue at that time showed that many improvements could be made in the system of transporting materials to the points of assembly in quantities sufficient to meet the needs. A better understanding of the possibilities of carrying materials to a central point led to the installation of conveying systems. For a time this method of transporting the materials to single points of assembly served well, but like the previous methods was outgrown because the desired schedule of production could not be fulfilled. During this period floor space also was increased, but even this gave relief only for a brief time.



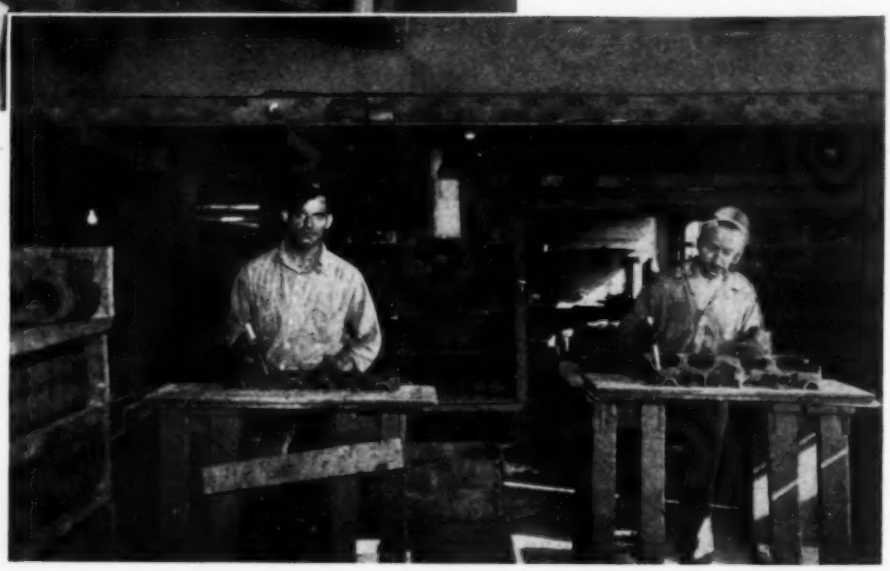


Fig. 2—(Left)—Steel Racks Carry the Cores into the Oven. Fig. 3—(Below)—Rapping Out the Cores

nBakes Cores

Rapidly

Increased floor space enabled the manufacturer to increase his production, but at the same time provided a handicap because of the added distances that materials had to be carried which in turn increased the cost of transportation. Various plans to remedy the situation were discussed and discarded until it was suggested that instead of transporting all materials to the various assembling points, that the materials be placed at a number of points in a line in the order in which they would be attached to the chassis of the automobile, and have the chassis move from point to point.

This system was tried out and worked so successfully that at the present time, the chassis is placed on one end of the conveyor line and a completely equipped automobile ready to be driven away by the buyer emerges at the other end of the line. Several advantages were gained by this method. Production was speeded up enormously with a reduction in space required for the operations. Assembly labor on each car was reduced considerably for although more men were employed in the new system to perform each single operation, the skill and rapidity with which they did the work, reduced commensurably the time involved.

While this method popularly known as the straight-line production method probably was developed to its highest efficiency by the automobile manufacturers, its use is not restricted by any means to this industry alone. Other industries, viewing the success of the method, adapted it to their particular needs, and at present the majority of industries having assembling operations apply it either wholly or in part. Although at times, the foundry industry has been pointed out as a glaring example of unprogressiveness in that the same methods that flourished fifty or a hundred years ago are still in use, this calumny is based upon data gained from a small minority of the foundries in operation today.

Fig. 4—Surface Grinding Gives Proper Thickness

Fig. 5—Distributing Cores to Storage or Molding Lines

A disinterested survey will show that the progressive foundrymen, the backbone of the industry, are not slow to take advantage of labor saving devices or apparatus that will assist in producing a uniform product. As in the case of the automobile manufacturer in the manufacturing industry, the automotive foundry in the foundry industry was the first to see the advantages that would eventuate by applying straight-line production methods. Now this system with various types of mold and sand handling apparatus has spread to the larger foundries except in those producing the heaviest cast ings.

Application of this principle of straight-line production is illustrated admirably in the foundry of the Lakey Foundry & Machine Co., Muskegon, Mich. In this plant, the various operations included in turning out a finished casting are arranged so that they follow in successive order using conveyors to transport the mold in the various stages of completion. Only in one instance are the castings loaded on trucks, and that is in transporting them to and from the core knockout department. Since the operation is extremely dusty, it was decided to install that

Fig. 6—Exit End of Conveyor Belt at Left. Cores Are Blacked at Right

department with its vibrating, core-removing equipment outside the foundry proper, and at a point in the opposite direction from where the molds are shaken out. The location was governed by the fact that since the burned core sand has to be removed from the plant, it would be most convenient to place the knockout department near the railroad siding which happens to be located at the back of the plant.

Enumerates Departments

Briefly the plant consists of a core department employing both the continuous type and the standard type core ovens, a foundry using five lines of mold and sand handling equipment for making cylinder blocks, which will be described in a second article, and a foundry similarly equipped for turning out flywheels, transmission cases, etc. Each foundry has a cleaning and inspection department. In addition to these the cylinder block foundry has a water test department for examining the water jackets for leakage. The continuous oven used in the core department is gas-fired. The baked cores are transported on a continuous belt to a finishing department where they are filed, pasted and blacked. After passage through another smaller oven for drying, they are placed on a belt that carries them to the storage racks or to the molding lines where they are needed.

The cylinder foundry contains five molding lines using mold-handling, conveying systems. Each line includes four molding machines mounted in a single line. The molding machines which are of the jolt-squeeze, patterndraw type, produce two cope and two drag molds. Special steel flasks of the firm's own design are used. The flasks have an opening on one side through which the core print extends. A steel plate faced with molding sand covers the end of the print when the castings are poured. Core trays on a moving belt supply the cores to three core setters on each line. As high as 700 molds have been made in a day on a molding line with an average production over a period of a month of 611 molds.

Dry-sand, strainer gates with runner cups are placed on each mold. The molds are poured from a 1-ton ladle transported by an electric hoist traveling on a monorail system. Metal in the 1-ton ladle will pour approximately 15 molds. From the pouring station the molds are carried to the shakeout. The castings are piled on trucks and are transported to the core knockout previously mentioned. After the cores are removed the castings are taken back to the cleaning department where they are rattled in large tumbling barrels. The castings then are ground with electrically driven swing grinders to remove high spots caused by fins, gates, etc. From the swing grinders the castings are moved on roller conveyors to the chippers who remove excess metal inaccessible to the swing grinders. The castings then pass through the sandblast cabinets and to the final cleaning department where internal core wires are removed and the water jackets inspected for freedom from sand.

Test and Inspect Castings

After this operation the castings slide on roller conveyors to the water test where they are tested under 60 pounds per square inch pressure for leakage. Following the water test, the castings pass to the final inspection department where they are gaged for accuracy of alignment. From this inspection department the castings are transported by roller conveyors to the painting or spraying division. Some of the castings are sprayed inside and outside; some either on the inside or on the outside, and others are not sprayed at all. Then the castings are loaded on trucks and are ready for machining or shipment.

Due to the large number of cores used in automotive castings, the department engaged in producing them

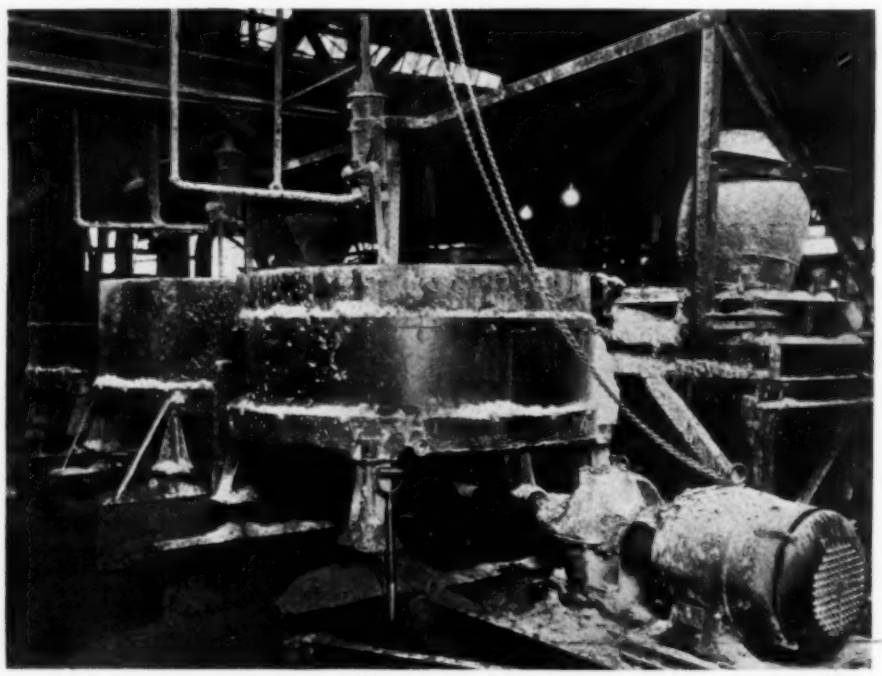


Fig. 7—Three Muller Type Machines Are Used for Blending Sand and Oil

must be capable of supplying the demand in a uniform stream without hitches which would cause an oversupply at one period and a dearth of cores at another. To that end the Lakey Foundry & Machine Co. has arranged its core room for straight-line production. Through this arrangement the cores are moved from the coremakers' hands, through the ovens, filing and blacking operations, etc., to the storage racks or to the molding lines without any back tracking.

Mix Sand Mechanically

Sand for the cores is elevated to a storage hopper on the second floor of a building which houses part of the final cleaning department on the ground floor, and the core room above. The sand is mixed in a room, adjoining the core room proper, in three muller type mixers made by the National Engineering Co., Chicago, and shown in Fig. 7. The sand is dumped from the storage hoppers into a side dump car which runs on an elevated track at the right of the mixers. It is emptied into the mixers and the requisite amounts of core oil and water added to give the desired bond.

After a period of mixing calculated to incorporate the various ingredients into a homogeneous mass, the gates at the bottom of the mixers are opened and the sand falls into two-wheeled carts which are used to convey the sand to the coremakers' benches in the adjoining room. As shown in Figs. 1 and 8, cores are made on hand-jolt molding machines supplied by the International Molding Machine Co., Chicago, Arcade Mfg. Co., Freeport, Ill., and the Osborn Mfg. Co., Cleveland. At the machines the cores are turned out on flat steel plates which are placed on the moving racks and slowly carried through the continuous oven.

Fig. 9—Cores Are Made in Sections Which Later Are Assembled As One

The continuous oven, supplied by the Swartwout Co., Cleveland, is gas-fired. It is of the horizontal type, and is mounted approximately six feet above the floor level. The oven has an overall length of 126 feet. A vertical cooling section about 35 feet high is located at one end. The oven is fired with automatically controlled burners placed about 6 feet apart in the baking section which is about 108 feet long. Cores are carried through the oven on steel racks containing five shelves. Each rack is suspended from a single, freely turning axle mounted between four flanged wheels placed two on either side. The wheels travel on medium-weight steel rails and are joined together by sections of linked chain. The racks are approximately 3 feet high, 3½ feet wide and 5 feet deep. Since the racks are 6 feet between centers, there is a space of about 2½ feet between successive racks.

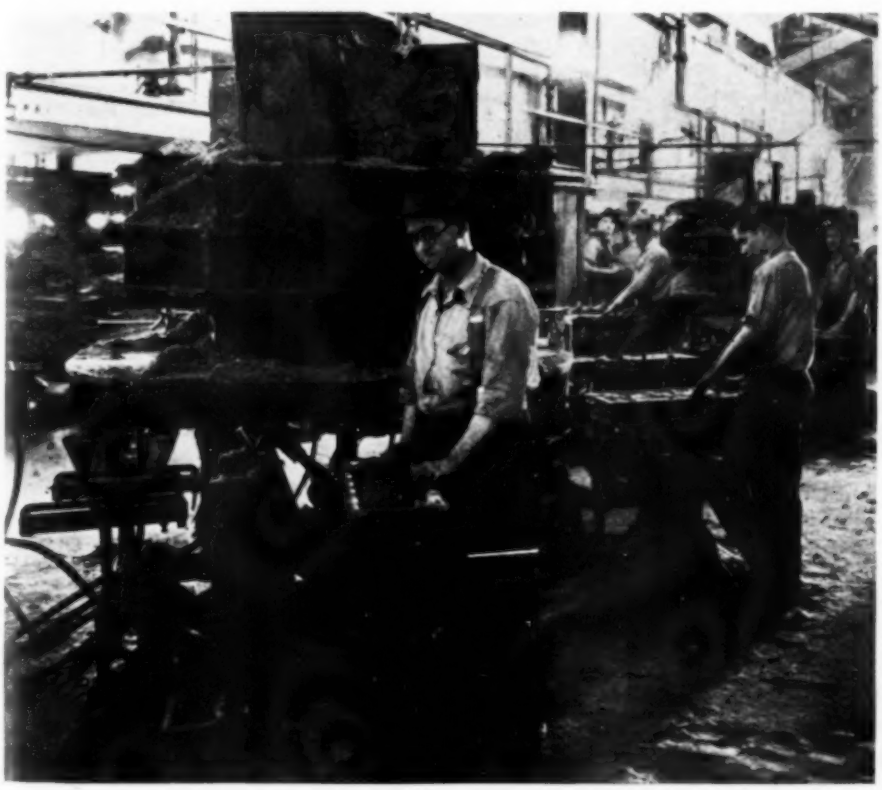


Fig. 8—Another View of the Coreroom Showing Hand-jolt Core Machines

Racks Move Slowly

As mentioned the coremakers on either side of the oven place the cores on the racks as they slowly move by the benches. The racks move at a speed of approximately 19.8 inches or 1.65 feet per minute. A complete cycle of a rack occupies about 3¼ hours of which approximately 1 hour and 10 minutes is devoted to baking, 1 hour for cooling in the vertical tower, and the remainder of the time is occupied in moving from the exit of the oven to the entrance. Temperatures in the oven are regulated so that the cores will be dried uniformly throughout, and to that end a temperature of 460 degrees Fahr. is maintained in the front section of the oven, and 470 degrees Fahr. in the back part.

Fig. 2 shows the entrance end of the oven with one rack starting on its short upward flight of about 10 feet. At the end of this rise, the wheels supporting the axle rest on the horizontal rails in the oven. The

racks then travel slowly through the length of the oven to the opposite end. At this point the racks ascend vertically about 26 feet into the cooling section of the oven, then travel about 18 feet horizontally and descend about 35 feet. At the end of the 35-foot drop the racks are moved 18 feet horizontally in the opposite direction to that previously mentioned, then make a rise of about 3 feet and travel horizontally under the oven to the entrance.

Placed on Conveyor Belt

Cores are removed from the racks during the last mentioned 18-foot section, and rapped from the drying boxes or plates as the case may be as shown in Fig. 3. The drying boxes and plates are returned to the racks and the cores are given a preliminary, rough filing to remove the most obvious fins along the edges and large openings in the cores. The cores then are placed on a conveyor belt which is just at the left of the workmen shown in Fig. 3. The belt is about 24 inches wide and 125 feet long, and extends from the core rapping room to the filing and finishing department which is at a slightly lower level. The exit end of the belt is shown at the left in Fig. 6. Other heavier types of cores are placed in wooden tote boxes without sides as shown at the left in Fig. 3. These boxes are placed on steel chutes which convey them to the filing department as in the case of the other cores. The exit ends of the chutes are to the right of the conveyor belt and are shown in the right background of Fig. 9.

In the filing department the cores are filed and brushed carefully to remove sand from the core openings and provide a smooth, clean core. After filing, the cores are placed on the shelves conveniently arranged around the room. The cores are removed from the shelves as required and inspected to see that they meet specifications, and are placed upon other slowly moving conveyor belts similar to that shown in Fig. 9 where the various sections are assembled and pasted to form a single core. The assembled cores are transported to the dipping or blacking tank.

After they are dipped in the blacking tank, the cores are placed on flat steel plates which are conveyed through a long, continuous type, drying oven. The oven, which is gas fired, dries the blacking and paste. As the cores come out of the oven they are placed on trays which, when filled, are carried to an elevator. The elevator conveys the cores to the floor below where the jacket cores are ground to size. Cores are ground on vertical spindle machines shown in Fig. 4. As may be seen, the table of the machine contains three jigs which hold the cores so that the upper part of the core presents a plane, horizontal surface to the grinding wheel, and in such position that any excess thickness may be removed.

The table rotates in a horizontal plane and brings each jig with its core, in turn, under the abrasive wheel which also revolves horizontally. A handwheel at the right of the machine permits adjustment of the height of the table so that any definite cut may be made on the cores as they pass under the wheel. In this way the thickness of the cores can be adjusted to meet any required specification.

After grinding to size the cores are placed on racks and sent to the assemblers who paste the various sections together. The pasted cores then are sent through a drying oven similar to that mentioned previously. When the cores are cooled, they are inspected to see that they meet requirements and then are placed on storage racks, or placed on trays which carry them to the molding stations.

Fig. 5 shows part of the conveying line used to transport cores to and from the storage racks. In the background and at right angles to this conveyor belt is shown one of the five lines leading to the molding stations. As previously mentioned, cores from the inspectors' lines or from the storage racks are placed on trays. These trays are made of aluminum about ¾-inch thick and are approximately 18 x 24 inches. Cores are placed on the trays in such order that when they reach the molding stations, the core setters can remove them in the order in which they are placed in the mold.

Blower Companies Merge

The Stacy Engineering Co., Columbus, O., has taken over the P. H. & F. M. Roots Co., Connersville, Ind. The firm has acquired the Connersville Blower Co., Connersville, Ind., the Wilbraham-Green Blower Co., Pottstown, Pa., and the Stacy Bros. Gas Construction Co., Cincinnati, during the past year. New officers of the Roots company have been elected and include the following: Col. Carmi A. Thompson, Cleveland, president; Corwin Abbott, Connersville, Ind., vice president and general manager; Fletcher S. Heath, Columbus, O., vice president; Erle G. Meeks, secretary and treasurer. Charles T. Gordon Connersville, Ind., will continue to act as general superintendent.

E. D. Johnston, for the past 45 years connected with the Roots company, has resigned as president and will retire from business. The new board of directors of the Roots company will include Col. Thompson, F. S. Heath, and C. A. Ward of Columbus, O.; W. B. Stacy, Cincinnati; J. T. Wilkin, Corwin Abbott and Charles T. Gordon, Connersville, Ind.

All companies involved in the merger will maintain their separate identities and organizations. They also will continue to operate separately until the final plans for the merger have been completed.

Builds New Plant

Norton Co., Worcester, Mass., grinding wheel and equipment manufacturers, has begun the construction of a grinding wheel manufacturing plant at Welwyn, Garden City, Hertfordshire, England. The initial group of buildings will include a one-story kiln building, four-story manufacturing building and a two-story building devoted to inspection, packing, shipping and office space. The company also has built a new service building at Chicago located at Forty-seventh place and Turner avenue.

Develop New Standard

According to a report recently issued by the American Standards association, New York, a draft of the proposed standard for cast iron pipe flanges and flanged fittings for maximum nonshock working hydraulic pressure of 800 pounds per square inch (gage) at ordinary air temperatures, has been worked out by a subcommittee on pipe fittings on pipe flanges and fittings under chairman C. P. Bliss, New York university, New York. This draft has been submitted for approval to the joint sponsors, the Heating and Piping Contractors' National association, the Manufacturers Standardization Society of the Valve and Fittings Industry, and the American Society of Mechanical Engineers. After approval by the sponsor bodies, the draft will be submitted to the American Standards association for approval as a standard. Copies of the draft are available for loan through the association.

During 1928 the domestic production of magnesium ingots was nearly 350,000 pounds which was an increase of 37 per cent over that in 1927 according to a bureau of mines publication.

American Brass Foundry Practice

By Charles Vickers

Part V—Arranging Pouring Position

ONE of the many interesting problems which the metallurgist has given much attention relates to the changes taking place when a molten metal or alloy reverts to the solid state again. A number of theories have been evolved to account for the manner in which this change takes place, but so far the problem does not appear to be solved satisfactorily. It is a matter of common knowledge that crystals are formed as the metals cool, but just what occurs during this change, and how it is brought about is difficult to discover because the action is hidden from observation by the nature of the material involved.

Explains Solidification

One theory accounting for the formation of crystals in a molten metal as its temperature falls, assumes that a separation occurs in which a number of alloys of differing compositions and differing melting points are formed. The first alloy produced, consisting largely of the alloy with the highest melting point forms nuclei around which the alloys of lower melting point solidify in the order of their melting points and thus build up the crystals. Because the growth of each crystal is limited by contact with its neighbors the size of the crystals will be determined by the number of nuclei formed at the beginning of solidification. Thus according to this theory the crystal grows with a structure like an onion. When the crystals have all formed, and the available space is filled entirely by the contacting crystals, the alloy containing the highest percentage of the most fusible metal of the alloy still is left. This cannot surround the last layer of the onion formation. Therefore, it has to squeeze between the crystals, which are irregularly shaped so they fit together like the cells of a honeycomb. This metal of the lowest melting point is known as the eutectic.

Beilby developed the theory that this substance constitutes an amorphous cement between the grains and is the substance that cements the crystals together, and also fills the voids between the crystals. As cooling proceeds the various layers of alloys constituting the crystal diffuse, into one another and finally result in a homogenous solid. There are some things about this theory that call for a rather free exercise of the imagination. It is a convenient theory that regards the eutectic as being left out of the formation of crystals, and considers that the eutectic has to fill up the spaces between, thus cementing the mass together, and insuring solidity. Of course, there is the possibility that in the case of some particular alloys, this eutectic does surround the formed crystals, either completely or incompletely, and that the presence of impurities, gaseous or solid, may influence the disposition of eutectic. If it surrounds the crystals completely, vacant spaces may be left in between at certain places, and the castings will leak under pressure whereas when the crystals are incompletely surrounded, sufficient eutectic exudes into the spaces to fill them up, giving sound metal.

For example, consider the well known alloy; copper 85 per cent; tin 5 per cent; zinc 5 per cent and lead 5 per cent. This alloy is used extensively, and some founders appear to find it entirely satisfactory, even for pressure castings, while others encounter much trouble with the alloy. As will be shown later, the method of gating the castings, and particularly the arrangement of the patterns in the mold may be to blame. However, this is not always the case for thoughtfully arranged patterns have in all too many cases produced a devastating number of leakers. All that was necessary to stop this trouble was to add more lead to the alloy. The amount found to give good results is three per cent, thus making the lead the predominant fusible metal addition.

Pattern Arrangement Is Poor

The experience of numerous brass founders will support the above statement. That is one reason we frequently find red brasses in which the lead content is in excess of both the tin and zinc content used for making castings that are required to withstand moderate pressures, such as those of city water systems, and steam heating plants. As previously mentioned defective arrangement of

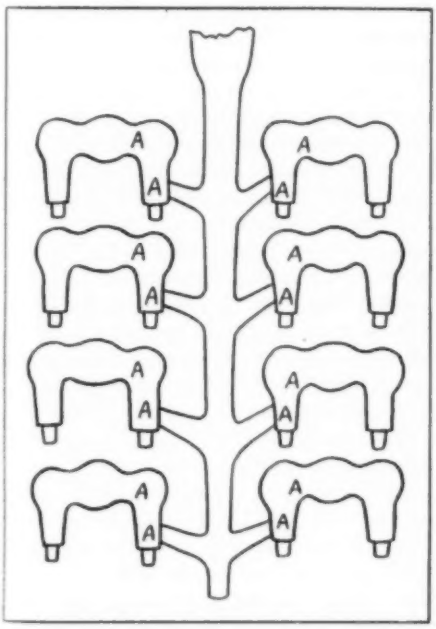


FIG. 4—MOLTEN METAL IN THESE CASTINGS HAS A TENDENCY TO FLOW FROM THE CASTINGS

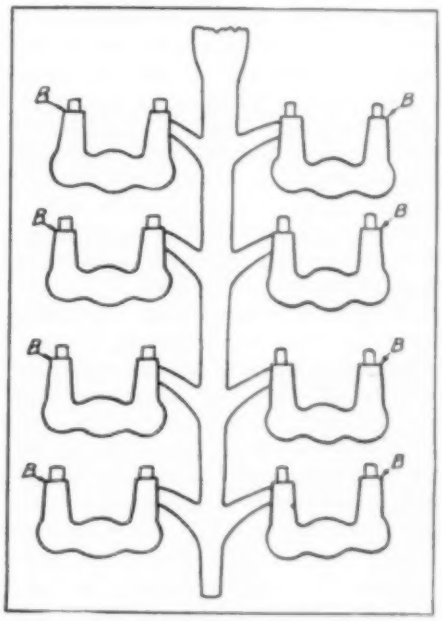


FIG. 5—RELATION OF CASTINGS TO GATES PERMITS ENTRY AND RETENTION OF MOLTEN METAL.

patterns may be responsible for heavy losses of castings due to leaking under pressure. Fig. 4, is an outline sketch of patterns for making hot and cold water mixing faucets to be cast in yellow brass. In this case the castings were molded to be cast upright, and poured through a hole in the top end of the flasks. A high percentage of leakers resulted from the method. A common sense study was made to discover the cause of this distressing state of affairs. The patterns were all marked so the position in which they were cast could be identified. It was then found that they leaked at the points marked *A* in Fig. 4. It also was determined that the first and second rows from the top provided the greater part of the leakers; the bottom row practically had no leakers, and the results with the row immediately above it were quite fair.

Gives Reason for Leaks

A little reflection shows just what occurred. The sprue bled the eutectic from the part of the castings nearest to it. The castings looked solid but they would not stand moderate pressures. The theory of the method of gating, of course was to fill up the sprue without getting little spills of metal into the cavities for the castings, which, of course, would have produced cold shuts, but it permitted the metal to flow into the casting cavities, and then to flow out again. At the instant when the eutectic still remained liquid it could seep away from the red hot crystals located at a higher point, which happened to be a part of a casting, down back into the sprue. The result was a nice and sound sprue, and a porous casting. Lead was not tried as a curative, for it was considered the metal was carrying all the lead that it was prudent to have in the alloy, more would have bled out. In spite of the use of cheap materials, the foundryman producing the work was not making money.

If the patterns had been arranged as shown in Fig. 5, there would have been no bleeding of eutectic. Bleeding would have been impossible, for while the same idea of filling the sprue without spilling into the casting matrices is carried out, these matrices are practically bags, which will hold the metal once it gets in. The metal does not run uphill to flow the castings in Fig. 5, as it does when leaving the gate in Fig. 4. Just the reverse takes place. From the gate it drops, thus gaining impetus to carry it across the horizontal part and rise in the second leg. It is aided materially in rising by a scratch vent located at a position B in Fig. 5.

Whether the onion structure of crystal formation is correct or not it is helpful to the practical man to be on talking terms with this theory. This is especially true when planning for gated patterns or match plates to produce castings which are expected to withstand pressures. The theory enables the foundryman to locate the patterns so that the metal will flow into the matrices made by them, and at the same time no portion of it can flow out again. The same thing as illustrated in Fig. 4, can also happen

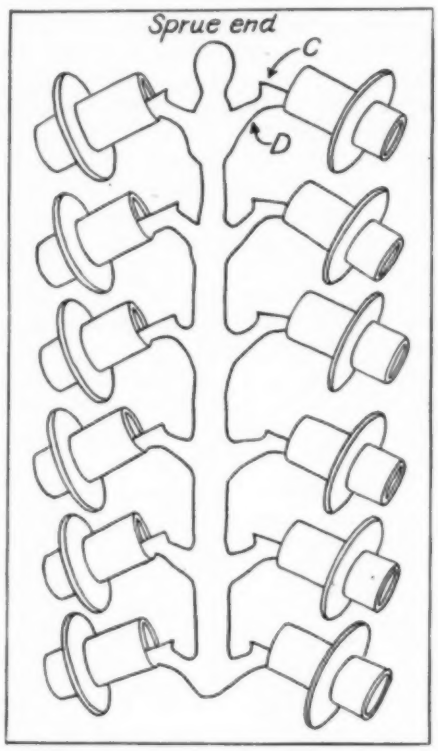


FIG. 6—THE LIQUID METAL CANNOT ESCAPE FROM THE CASTING

in the case of molds poured on the incline, as the match can be so laid out that the runner and gate will bleed some portion of the casting, and while the latter when removed from the sand may appear to be sound, the pressure test quickly shows that this is not the case.

When trouble is experienced because of a high percentage of leakers, the manner in which the patterns are laid out and gated and especially the position in which they are poured should be studied carefully. The first question to consider is whether or not, when looked at in a general way, the patterns are so arranged that the matrices formed by them, make a bag, into which the metal may easily flow and out of which it cannot escape.

An example of this is shown in Fig. 6. What chance is there for the metal to flow back to the gate at any period of its solidification? Even a portion of the gate has to flow by gravity into the casting. True, the part of the gate at *D* will feed the runner, but by the time it gets to this point of solidification, passage shown at *C* is closed. The castings made from this gate did not leak. However, had the patterns been arranged the other way, so that the metal had to flow uphill to make the castings, the castings would have been like a bag with the mouth down. A portion of the eutectic would have been in a position to flow out of the castings to feed the gate.

They might look all right coming from the sand, and even after being machined, and not all of them would leak. Sometimes an entire heat would be good, but there are always *off days* and *off heats* to be considered, when the metal may not be as hot as it should be, even when pyrometers are used faithfully, and on those days, the scrap runs high. However, when the castings are gated as in Fig. 6, the chances of loss are reduced to the minimum. The molds for Fig. 6 were poured on a slight incline from the horizontal which follows the practice prevailing in the majority of American brass foundries.

Describes French Method

Fig. 7 shows a method of pouring bronze valves as practiced in France, and it will be noted that no possible chance is given any portion of the metal entering the molds to leak backward into the gates. This sketch was made in the foundry making the castings by a representative of an American equipment manufacturer. The following comments of the representative will be of interest: "The writer recently installed a pair of molding machines for the molding of a bronze valve as shown in drawing. As far as the machines are concerned, the work is progressing with satisfaction but the cost of production is far in excess of all reasonable estimates. With two machines, one making the copes and the other the drags, it is easy to obtain a production of 60 molds, with two pieces in the mold (120 pieces) in 20 working hours, but the great loss of time is in the finishing and the closing which occupies 47 working hours.

"Both halves of the mold are made on stripping plate jolt machines. The foreman insists on ramming the molds as hard as possible, jolting them 150 times with the machine striking as hard a blow as is possible to obtain, then butting off the top by striking the surface with a heavy rammer. The molds are then placed on the floor and soaked with a wash

composed of clay water and a special bluish powder which is mined in France. This wash is applied with a brush, great care being taken to apply as uniformly as possible, and to reach all points. This operation requires 10 minutes per mold. The molds are dried in ovens and returned to the floor the following day. Then they are assembled carefully in stacks of four molds, clamped together and placed on the side for pouring. The work is poured on end as shown in Fig. 7. The castings obtained from this slow process are fine, the surface being exceptionally smooth, and the metal sound. The mixture used for this work is 90 per cent copper; 8 per cent tin, and 2 per cent zinc. For the dry sand work, a facing sand rather coarse in texture is used. In this country (France) quality is the first consideration."

Gates the Casting

This method of molding with its system of gating and risering can be relied upon to produce a maximum amount of sound castings, but with a minimum production; 120 castings in 67 hours, or more than a week's working time, as judged by American standards. With no desire to make comparisons, there is little doubt that if these valve bodies were gated similarly to those in Fig. 6, production would be increased greatly with a corresponding reduction in the cost of the finished article.

In the case of some alloys it is desirable to have the crystal growth checked. Otherwise, the crystals will grow large, and as a result the alloy fails to reach the strength that is desirable. The alloys of copper and aluminum are instances in point. Some fourteen years ago the author conceived the idea of adding iron to the alloy of 10 per cent aluminum, 90 per cent copper to limit the crystal size by increasing the number of nuclei when the alloy started to solidify and thereby crowd each crystal so that it had no room for growth.

Although iron had been considered the most injurious element with which aluminum bronze could come into contact, it was selected as the one most suitable for refining the grain of the alloy. Brannt, *Metallic Alloys*, in his directions for making aluminum bronze states that the bronzes are so sensitive to the presence of iron that an aluminum with as small a percentage of this metal as possible should be used. The silicon in commercial aluminum he further states, is not so harmful as the iron. The reverse is actually the case. Dr. Joseph W. Richards suggested that the stirrers and skimmers used be coated with a wash of plumbago and a little fireclay, "— as the contact of bronze with the bare iron tools cannot but injure its quality." Possibly this theory of the injurious influence of iron on aluminum bronze retarded the commercial use of these alloys for many years. The result of these experiments with iron in aluminum bronze was a series of alloys covered by United States Patent No. 1,264,-459, April 30, 1918, issued to the author. One of the outstanding formulas described in this patent contained 86 per cent copper; 4 per cent iron, and 10 per cent aluminum which now is specified by the United States

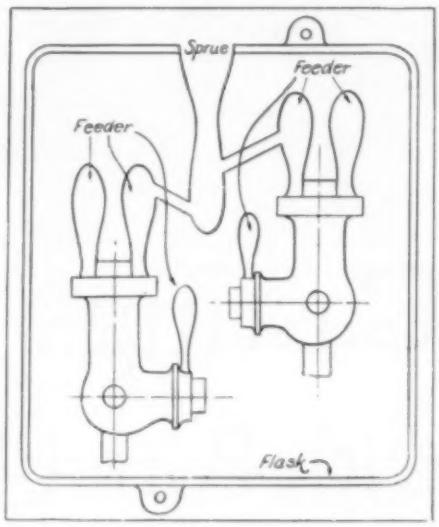


FIG. 7—SOLID CASTINGS ARE OBTAINED FROM THIS PATTERN DUE TO THE GATING AND FEEDERS

government for naval castings of high strength.

Another theory of the growth of crystals in metals, is that starting from the more quickly cooled surfaces, such as the sides of a mold as a base, the crystals branch out into the still liquid portion of the casting in the dendritic form. Since there are many crystals born at the same time from the cooling surface, they are all crowded together in three directions and have only free growth in the direction of the hot part towards the center of the casting. This dendritic structure resembles a Christmas tree and as the branches grow they interlock and grow thicker by the deposition of the alloys of lower cooling point, until at last the eutectic is reached and fills up any interstices left between the various branches. Of course, only the barest outline of this theory can be given, but as far as molding results are concerned, they are similar to those of the first theory, in that we have a eutectic which continues in the liquid state after the greater portion of the alloy has solidified. Therefore, the more fluid component can *bleed* from a higher to a lower point of a casting which necessitates precautions in molding and gating, similar to those just described as useful in the case of the onion structure theory. This dendritic hypothesis has many adherents. In fact it is quite easy to gather evidence in support of the theory.

If a long square bar of metal is poured in a metal mold, and fractured it may be observed how the crystals have formed on the mold-cooled sides, and have reached out towards the center of the bar. Where the growing crystals of one side have come into contact with those of the adjacent side, their growth has been checked. The result is that the fractured surface resembles a St. Andrews cross. This structure shows up quite plainly, for instance on the fractured surface of a bar of cobalt, one inch square, and in numerous other instances. The thought that crystals are built up from many little points throughout the body of the metal, and that their size can be regulated by the addition of some higher freezing point element, as in the case of refining the grain of aluminum bronze by iron additions, appears to be evidence in support of the first mentioned theory as to the growth of crystals.

Iron Is Not Cure-all

However, it must not be assumed that the addition of iron to gun metals, phosphor bronze and like alloys would work out in the same manner, for the reason that sufficient iron cannot be added to these latter alloys to greatly influence their structure. The reason for this is that iron has an affinity for carbon, while copper has not. Iron with carbon forms steel, cast iron or iron carbide as the case may be and these combinations are not soluble in copper. Therefore, the iron segregates as hard spots when the content of the iron-carbon alloy is comparatively low. When large quantities of iron are present, the copper and the iron separate into two layers. However, when some element is present that has a greater affinity for the iron than has carbon, it will throw out the carbon and form an alloy with the iron. This alloy of the two metals has the power to take in a third, so that it is quite easy to make an alloy of iron, aluminum and copper. Consequently, there is not the least difficulty in the case of aluminum bronze containing iron, either in the alloying or the machining, as far as the content of iron is concerned. All that is necessary to make alloys of cast iron and copper, is to add aluminum,

(*Concluded on Page* 86)

Fig. 1—(Right)—Objects Examined by X-rays Include an Oil Painting, Die Castings and Large 6-inch Cast Steel Tees. (Below)—Power for the X-ray Tube Is Regulated on This Control Panel

Castings X-rayed with Portable Apparatus

NUMEROUS useful applications of X-ray inspection in the industrial field have been pointed out from time to time, applications which have been carried out with X-ray apparatus in the laboratory. Recently the process has been carried into the plant in the inspection of heavy cast steel pipe fittings for high-pressure service.

To make certain of the soundness of steel castings for a recent 1350-pound pressure steam power plant piping installation, the owners of the station and their engineers determined to have these castings X-ray inspected before putting them into service. Since several of the fittings weighed more than 3 tons each it was decided to carry on the inspection at a place better equipped for handling such heavy objects than was the laboratory. Accordingly, the high-potential power plant was transferred to a suitable location near the steam plant. After completion of the inspection the equipment was returned to the laboratory. This is the first time in the history of X-ray examination that equipment powerful enough to examine steel 3 inches thick has been used as a transportable unit. The work was carried on under the direction of Herbert R. Isenburger Inc., 505 Fifth avenue, New York, with equipment from the laboratory of Dr. Ancel St. John, Long Island City, N. Y. The setup in the laboratory, shortly before the temporary removal of the equipment, is shown in Fig. 1. Objects on hand for inspection ranged from several old paintings to 6-inch cast-steel tees. Fig. 5 shows the temporary installation at the steam power plant.

The equipment consisted of power generating units, an X-ray tube with its housing and support, a movable platform on which the work to be investigated was mounted, and a dark room. For convenience and safety the power equipment shown in Fig. 2 is located close to the X-ray tube support and is protected by a sheet steel room or enclosure. The power supply includes special transformers which take the ordinary power service in the building, in this case 220-volt, single-phase alternating current, and convert it into 200,000-volt direct current for use on the X-ray tube. The tube itself is supported in a lead-lined box within a sheet steel case directly over the castings under investigation.

An opening in the lower part of the lead-lined box permits the passage of the rays downward through the

Collaborate on Article

FURTHER progress in the application of X-ray testing to the problems of internal inspection of steel is detailed in the accompanying article, wherein the X-ray apparatus has been transported directly into the plant for the examination of heavy fittings and piping for a high-pressure steam installation. The article has been arranged from material released by Herbert R. Isenburger and Dr. Ancel St. John, and partly from information secured by H. R. Simonds, associate editor of THE FOUNDRY, *after a recent visit to the scene of the testing operations. Mr. Isenburger is president of Herbert R. Isenburger Inc., industrial X-ray specialist, New York, and Dr. St. John is a consulting physicist, New York.*

wall of the casting to make a shadow picture on the film or films held in place within the casting.

The photographic films are placed in special cassettes on a carrier which fits inside of the casting. The design of this carrier must be changed of course to suit the different types of castings. A small flat car running on tracks which extend under the tube, facilitates the handling of the castings. During exposures the casting is surrounded by a lead covered housing which protects the operator and others in the vicinity against X-rays. This housing also travels along tracks under the tube. Electrical protection is provided by grounding all metal parts around the power supply and the X-ray tube. The dark room is similar to any well organized dark room. It is about 8 x 8 feet in size, with shelves for storing materials and an illuminated rack for examining films. Deep solution trays and a washing tank with running water are arranged on one side. The dark room as well as the power room and the exposure housing occupies a corner of the shop not exceeding 20 feet square.

Fig. 2—High Voltage for X-ray Tube Is Supplied by This Equipment

Involves Two Factors

The work of X-ray examination involves two factors, technique of X-ray photography and the study and interpretation of the photographs or exographs, as they have been termed. For an X-ray examination to have its full value, both of these phases of the work must be carried out with painstaking care and the skill which only can come with much experience.

The elaborate details necessitated in the X-ray examination of heavy steel fittings are for the most part beyond the scope of this article. They include such items as double sensitive coatings on films, intensifying screens, the use of absorbing lead solutions to counteract uneven sections of castings, lead shields for protection against reflected rays and the time and direction of exposure.

Some idea of the work may be had from a brief description of the procedure in connection with X-ray examination of a main manifold of the steam piping system, which is about 11 feet long and weighs approximately 7000 pounds. The main part of the casting has an internal diameter of 10 inches and a wall thickness of 2¼ inches. When such a casting is brought up by cranes and placed on the car for X-ray examination, the first step is to mark it thoroughly for identification in the exograph.

Lead Markers on Casting

This is accomplished by means of small lead stencils held in place by strips of adhesive tape. The lead markers are each about 1 x 2 inches in size. They are placed at regular intervals along strips of adhesive tape which are then wound around the casting to form sections throughout its length. On the casting in question the strips of lead markers are placed every 8 inches throughout the length of the manifold. The spacing around the casting is such that there are 12 markers for the full circumference in position like the hours on the face of a clock. All marking is done with the casting in exactly the same position as it was when poured in the foundry. That is, the risers on a cylindrical casting are at the point represented by the hour 12 on the clock, and all other points are figured from this line. The manifold, mounted for examination of the regions indicated by the white stripes, is shown in Fig. 3. In this view the lead housing has been rolled back; in Fig. 4 is the same setup but with the housing in position for an exposure.

The manifold having been marked as previously described, the next thing is to place it in accurate position on the car so that when pushed into place it will come directly under the X-ray tube, with the part to be exographed uppermost. Three pictures are taken at once, that is, three films are placed side by side within the cast-

Fig. 3—Pipe Manifold Mounted for Examination of Portions Indicated by White Markers; the Lead Housing Has Been Rolled Back. Fig. 4—The Same Setup with the Housing in Position for an Exposure

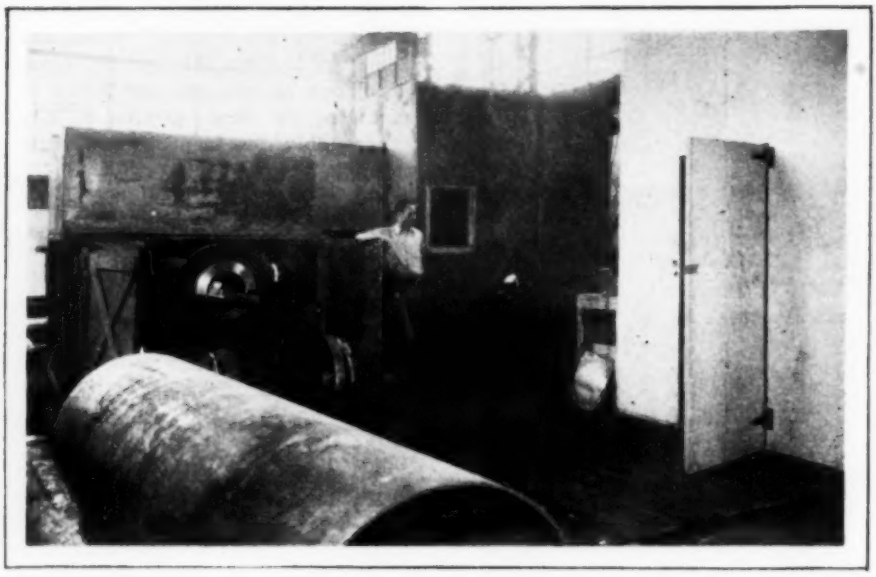


Fig. 5—The temporary Installation of X-ray Equipment at the Steam Power Plant. The X-ray Booth Is in the Left Background

ing so as to come in the exposure zone. A system has been worked out carefully so that by having the position of the car containing the castings at a definite point, it is possible to use graduated measuring sticks to place the films within the casting and have them come directly under the X-ray tube. With the castings in one position, exposures are started at one end and continue until the other end of the casting has been reached without altering its position. The position of the car and lead housing is altered of course for each exposure.

After each row of exposures is made the casting is revolved about its axis into position for the next row of exographs and the procedure is repeated. The length of time for each exposure varies of course with the thickness of the metal and with other conditions. The 6-inch tees, shown in Fig. 1, required about 5 hours each for complete X-ray inspection; but for the manifold castings in all positions exposures of 10-30 minutes are used, and about 125 exographs are required to cover completely the surface of a manifold casting, thus consuming upward of 30 hours exposure time in addition to 10 hours required for arranging the casting and placing films.

The operating apparatus is simple, consisting of a few small controls outside of the power room. When a casting is ready for an X-ray photograph with the films in place the lead-lined doors are closed and the throwing of a few small switches sets the apparatus in operation. A kilovolt meter mounted close to the control switches indicates the voltage across the tube terminals. This voltage may be checked if desired by a device which measures the length of the spark gap. A spark gap of about 15 inches was indicated during one of the exposures. As soon as the current is on and the tube is in operation, the operator starts a photographer's alarm clock, set to ring at the end of the exposure, and by this means avoids the danger of overexposure. At the end of the exposure time the current is shut off, the door is opened, the film taken out, placed in the dark room for developing, and a new set of films inserted in the X-ray cassettes.

The regular procedure as described must be altered of course when the surface between the outlets is being examined. This necessitates a greater distance between the tube and the films and requires a longer time for exposure. Other modifications are necessary when examining the walls of the outlets.

When all the exographs required for the complete investigation of a casting are made and developed they are carefully tabulated and filed for reference. The system of marking is so complete that the indication of a defect in one of the exographs makes it possible to locate accurately that defect within the casting itself.

The method of using a liquid absorber to equalize the exposure rate of an uneven metal section is inter-

Fig. 6—Exograph of Sound Steel. The Parallel Bands Are Screw Threads Cut in the Inner Surface of the Steel.
Fig. 7—Double Exposure exograph of a Pipe Fitting Revealing a Fairly Large Sand Inclusion. Depth of the Inclusion Beneath the Surface Is Determined by Double Exposure

esting. The absorber, a lead solution, is carefully prepared so that it will have the same resistance to the passage of the X-rays that the casting has. Then if the casting is small enough it is merely immersed in this solution, and the exograph may be taken in any manner desired without being affected in the least by the variation in casting thickness.

Few X-ray pictures of sound steel have been published, probably because they usually show nothing of special interest. Fig. 6 represents such a picture, however. The rectangular dark patch with the number 3.5 is a lead marker identifying the area examined. The parallel bands are screw threads cut on the inner surface of the steel. The light spot in the upper right-hand corner is not a defect but is the inner end of a hole drilled through the wall.

X-ray tests, confirmed by sectioning or other collateral analyses, indicate that undesirable internal conditions in castings fall into relatively few classes, all traceable to definite and simple causes. Most of these causes, if not all of them, can be eliminated by proper foundry practice. Experience shows that when chronic defects have been corrected by making the indicated changes in casting technique, such as changing gates, riser heads, or air vents, they tend to stay corrected. It is possible thus to eliminate from 75 to 90 per cent of the major defects.

Principal undesirable conditions in castings are:

1. Gas, slag and sand pockets due to loose dirt in the mold.
2. Gas cavities due to imperfectly deoxidized metal.
3. Sand inclusions due to cutting of mold or runners.
4. Pipe or primary shrinkage caused by failure of risers to function as intended.
5. Secondary pipes caused by flow of viscous metal through constricted channels in the casting during the final stages of solidification.
6. Shrinkage cracks starting from a sinus-like cavity developed during cooling.
7. Rupture developed during hydrostatic test.

Accompanying illustrations represent typical X-ray pictures showing a few of these defects. They have been selected chiefly from work performed at the laboratory of Dr. St. John. Fig. 7 is a double exposure of a region containing a fairly large sand inclusion. Between exposures the casting was shifted slightly without changing the position of the film within it. The shadows of the numbered marker were displaced ⅝ inch, of various parts of the inclusion 9/16 inch or more and a small spot below the marker ⅜ inch. This spot was on the inner surface and the marker on the outer. Hence the inclusion lies just under the outer surface and nowhere penetrates more than one quarter the way through the wall.

Fig. 8, left, shows primary pipe or shrinkage cavities extending through the flange from the heavy section at the junction of flange and wall of a small valve body. A gas pocket, a sinus-like cavity and extended secondary pipe or shrinkage cracks appear in the center, Fig. 8, taken from the main wall of a 6-inch tee fitting. In the exograph at the right in Fig. 8, from the wall of a 3-inch ell, the clear cut "shepherd's crack" represents a cold crack starting from a small inclusion and developed by the hydrostatic test, which had been passed successfully.

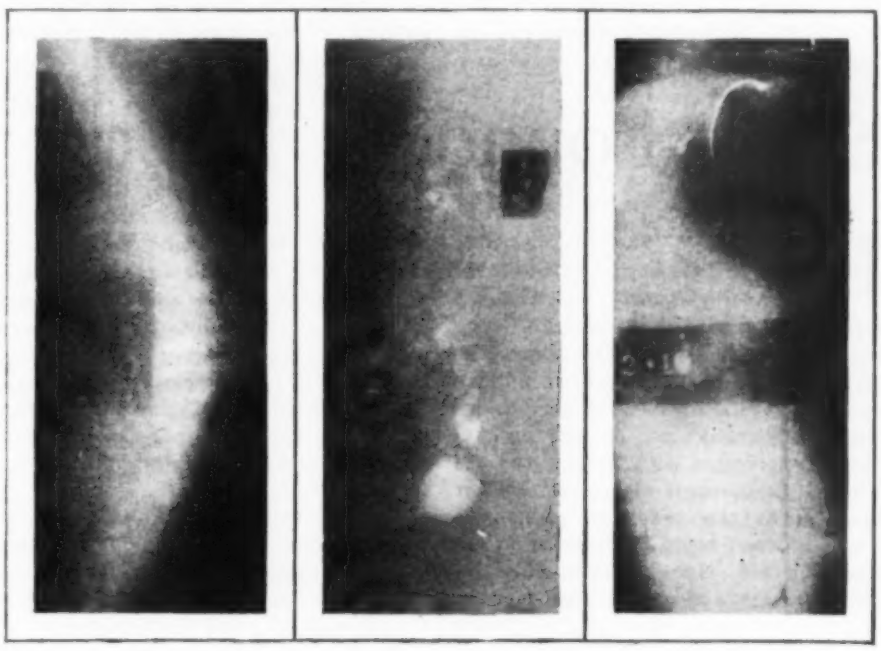


Fig. 8—(Left)—Exograph Showing Primary Pipe or Shrinkage Cavities. (Center)—Secondary Pipe or Shrinkage Cracks. (Right)—A Clear Cut "Shepherd's Crack" Visible at the Top of the Exograph

To Hold March Meeting

On March 5 the Wisconsin Gray Iron group will hold a meeting in Milwaukee. B. H. Johnson, Florence Pipe Foundry & Machine Co., Florence, N. J., will talk on the "Psychology of Cast Iron."

Will Meet in St. Louis

The St. Louis District Foundrymen's club will hold a meeting in St. Louis on Feb. 28. D. G. Anderson, foundry development engineer, Western Electric Co., Chicago, will be the principal speaker.

Arrange Program for Meeting of A. I. M. E.

According to the tentative program recently issued by the American Institute of Mining and Metallurgical Engineers, a wide range of subjects will be included in the papers to be presented at its forthcoming annual meeting to be held in the Engineering Societies' building, New York, from Feb. 17 to 21. The iron and steel section will open its sessions on the afternoon of Feb. 19 with discussion on ores and foundry practice. On Feb. 20 sessions will be held in the morning and afternoon. Included in the papers to be presented at the sessions are the following: "Production of Gray Iron from Steel Scrap in the Electric Furnace," by T. F. Baily; "Reclaiming Steel Foundry Sands," by A. H. Dierker; "The Influence of the Rate of Cooling on the Dendritic Structure and Microstructure of Some Hypoeutectoid Steel," by Albert Sauveur and C. H. Chou; "Rate of Carbon Elimination and the Degree of Oxidation of the Metal Bath in Basic Open-hearth Practice, II," by A. L. Field and "A New Method for Determining Iron Oxide in Liquid Steel," by C. H. Herty Jr., J. M. Gaines Jr., H. Freeman, and M. W. Lightner. Following the session in the afternoon of Feb. 20, Dr. Zay Jeffries will present the Howe Memorial lecture taking for his subject, "The Future of the American Iron and Steel Industry."

The Institute of Metals division of the A.I.M.E. will present an exten-

sive program of papers starting on the afternoon of Feb. 18 with a session on corrosion and general subjects. Two sessions on Feb. 19 will be devoted to copper and brass and at 4 p.m., Dr. S. L. Hoyt will deliver the annual Institute lecture. His subject is "Hard Metal Carbides and Cemented Tungsten Carbide." On Feb. 20 the institute will hold a symposium on the melting and casting of metals and in the evening the annual dinner will take place at the Savoy-Plaza hotel. G. H. Clamer, Ajax Metal Co., will speak on, "The Induction Furnace for the Melting of Metals." Included in the papers to be presented are the following: "Effect of Oxidation on Certain Impurities in Bronze," by J. W. Bolton and S. A. Weigand; "Monel Metal and Nickel Foundry Practice," by E. S. Wheeler; "The Influence of Silicon in Foundry Red Brasses," by H. M. St. John, G. K. Eggleston and T. Rynalski; "Melting Bearing Bronze in Open-flame Furnaces," by E. R. Darby, and "Oxides in Brass," by O. W. Ellis.

The institute will conduct its annual business meeting on Feb. 18. A feature of the four-day meeting will be an exhibit of rare metals and minerals in the Engineering Societies library. The display will consist of rare specimens from the private collections of members of the institute.

The James Douglas medal will be presented to John Van Nostrand Dorr and the Robert W. Hunt medal to James Aston at the annual dinner of the A.I.M.E. to be held at the Commodore hotel, Feb. 19. William S. Unger will be the recipient of the J. E. Johnson Jr. award for 1930. The Class of 1880 Legion of Honor men will be welcomed. The new president, will be introduced and the retiring president, Fred W. Bradley, will deliver his presidential address.

Special excursions have been planned to the Bell Telephone Laboratories, the Museum of Peaceful Arts, and the Lighting Institute at Grand Central Palace.

Steel Founders Report on Business

EXCELLENT business reports marked the meeting of the Steel Founders' Society of America held in Chicago Jan. 27 and 28. The first day was devoted to committee sessions, and meetings of the officers and directors. Members of the society with practically no exceptions, reported operations satisfactory and affirmed their expectation of better business as the year progresses. A slight upward trend in castings prices was reported. Inquiries are plentiful from railway and agricultural sources and some increase is noted from truck and automotive firms.

An all day session held at the hotel Tuesday was attended by 88 steel foundrymen, members and guests of the society. John E. McCauley, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., president of the organization, introduced Arthur Simonson, Falk Corp., Milwaukee, vice president and chairman of the midwest-southern section, who presided. The morning meeting was devoted to reports of committees and of Granville P. Rogers, managing director. In his report, Mr. Rogers noted growth of the society since its reorganization in November, 1929. The seal and insignia of the society has been generally adopted by members. An employment bureau has been established and the organization plans to employ a technical advisor with experience in foundry and metallurgical lines to advise with members.

George H. Friesel, United Engineering & Foundry Co., Pittsburgh, reporting for W. J. Corbett, chairman of the cost committee, noted progress in revising the standard cost system of the society.

Progress also was reported by H. S. Falk, Falk Corp., Milwaukee, chairman of the industrial research committee, and R. J. Doty, Reading Steel Casting Co., Reading, Pa., chairman of the technical research committee. S. W. Utley, Detroit Steel Casting Co., Detroit, chairman of the membership committee noted an increase of seven members since the Pittsburgh group meeting Dec. 12 and 13.

The afternoon session was devoted to a general discussion of new uses of steel castings, led by Frank D. Glosser, Commercial Steel Castings Co., Marion, O., and participated in by a number of members who spoke of specific castings which through greater utility, corrosion resistance, lightness with strength or lower costs recommended themselves for service.

Following the general session, the heavy castings division, under chairmanship of Mr. Friesel met and discussed cost operating data. Simultaneously, the small castings division met and organized with L. H. Peregoy, Sivyer Steel Casting Co., Milwaukee, as chairman. Two papers were read and discussed.

The first paper on handling pattern equipment, read by W. J. Donnelly, Geo. H. Smith Steel Casting Co., Milwaukee, called attention to the wear and unavoidable damage expense now assessed against the foundry, which with the precedent of other trades, notably the replacement cost of cuts in the printing industry, should be borne by the customer. Prices on castings, too frequently, are quoted without due regard to type, suitability or condition of pattern equipment. The expense of rendering such equipment serviceable constitutes a heavy drain upon foundries, running in many cases to thousands of dollars a year. Furthermore, the foundries themselves too often cannot agree on the best type of pattern equipment and consequently, patterns removed from one shop to another must undergo many costly changes which should be avoided. The speaker urged more general use of the standard pattern color markings of the American Foundrymen's association, the Steel Founders' Society and other co-operating bodies. The foundry should advise with customers on the details of pattern and corebox equipment.

The second paper by C. A. McDonald, Nugent Steel Casting Co., Chicago, covered detailed costs of repairs and maintenance labor.

Monday, Jan. 27, was devoted to committee meetings and to a meeting of the board of directors at which it was decided that the next district meeting of the society will be held in Philadelphia, Feb. 27.

Installs New Equipment

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., is revamping its foundries at Springfield, Mass., Trafford, Pa., and Cleveland. New sand and mold handling equipment is being installed. A portion of the foundry of the Cleveland plant is being moved to Trafford, Pa., and the street lighting section formerly located at South Bend, Ind., is being moved to Cleveland. This new department will include a brass foundry unit.

The National Radiator Corp. has removed its executive offices from New York to Johnstown, Pa., where they are being consolidated with the general offices.

Unify Gray Iron Costs

Gray Iron Institute, After Year of Study and Research, Offers Standard Cost System to Industry

SECTIONS of the standard cost system developed by the cost committee of the Gray Iron institute have been presented in the Jan. 15 and Feb. 1 issues of THE FOUNDRY. The material in this, the third and concluding installment, deals with the distribution of overhead and other expenses.

DISTRIBUTION OF GENERAL OVERHEAD

General Overhead

The entire general overhead must be allocated to the four manufacturing departments and be completely absorbed by them, becoming a part of their department overheads.

Fixed Charges

The fixed charges are allocated to the four manufacturing departments at the beginning of the year. A fixed charge per month for each department is determined, and thereafter the same charge is used each month unless there are important changes in the building or equipment accounts.

Taxes, insurance, and depreciation should all be divided as nearly as possible in proportion to the value of the total investment in each department. This should always be done in the case of depreciation of equipment. Taxes, insurance, and depreciation of buildings can often be apportioned with sufficient accuracy on the basis of floor space.

Heat, Light and Power

This expense should be allocated in proportion to the actual or estimated consumption of power and heat in each department. A percentage for each department is determined at the beginning of the year, and thereafter this percentage is applied to the actual cost of power and heat for each month.

General Expense

The total general expense including plant, general, administrative, and selling expense is allocated each month to the four manufacturing departments in proportion to the total payroll (direct and indirect) of each department.

Note: If auxiliary departments (such as carpenter shop, pattern shop, maintenance department, or heat, light and power department) are carried, or if any of the main departments are subdivided into subdepartments (such as 4A, 4B, etc.) the general overhead is allocated to such auxiliary or subdepartments in the same manner as described for the four manufacturing departments.

All general overhead has now been disposed of and becomes a part of the departmental overhead.

DISTRIBUTION OF DEPARTMENT OVERHEAD

1. Melting Department

The entire cost of the melting department, the total of all accounts from 10 to 19, is combined into one total amount for the month. This total cost divided by the pounds of *good castings produced* gives the cost of melted metal per pound of good castings produced, which can be applied directly to individual jobs on a pound basis.

Note: The cost of the metal at the spout is obtained by dividing the total cost of the melting department by the total pounds of good castings produced. If this average cost is applied to all jobs, light or heavy, there will be a slight inaccuracy due to the fact that for very light castings the weight of gates and sprues is a much larger proportion of the weight of good castings in the mold, than in the case of very heavy castings. We may have to melt 300 pounds of metal to get 100 pounds of good castings in one case, whereas in the other case we may only melt 120 pounds of metal to get 100 pounds of good castings. The extra metal is, of course, used over again so that the only additional cost is for fuel, labor, etc., used in melting.

In malleable and steel foundries, this is an important item and must be taken into account; but in gray iron foundries it is not so important. A gray iron foundry which produces all light work, or all heavy work, may use the same cost of melted metal per pound of *good castings produced* for its entire output. Where both light and heavy work are produced, it is recommended that the cost of melted metal used for light work be slightly higher than the average, and for the heavy work slightly lower than the average. The correct figures for each should be determined by actual test.

2. Molding Department (Procedure for Light Foundries)

The total of accounts from 22 to 29 gives the total molding overhead. This total divided by *molding direct labor* (account 21) gives molding overhead percentage. This percentage is applied to individual jobs on the basis of molding direct labor.

2. Molding Department (Procedure for Heavy Foundries)

2 A. Distribution on Direct Labor Basis: The total of accounts 22-2, 25, 26, 28, 29-1, 29-2A and 29-3 gives the molding overhead chargeable to individual jobs on a *direct labor* basis. This total divided by *molding direct labor* (account 21) gives the molding overhead percentage applicable to direct labor. This percentage is applied to individual jobs on the basis of direct molding labor.

2 B. Distribution on Tonnage Basis: The total of accounts 22-1, 23, 27 and 29-2B gives the molding overhead chargeable to individual jobs on a *tonnage* basis. This total is divided by the pounds of good castings produced which gives the cost per pound. The cost per pound so determined is applied to individual jobs on a pound basis.

3. Core Department

The total of all accounts from 32 to 39 gives the total core overhead. This total divided by *core direct labor* (account 31) gives core overhead percentage. This percentage is applied to individual jobs on the basis of core direct labor.

4. Cleaning and Shipping Department

It is the practice of many foundries to carry the entire expense of the cleaning and shipping department in one account and later prorate it either on a tonnage basis or as an overhead on direct molding labor. Both of these methods herein referred to as alternative methods for distributing cleaning and shipping costs have been accepted as satisfactory as they are accurate enough for all practical purposes for about 80 per cent or 90

per cent of the work in the average foundry. Any foundry may use either method, both of which are shown hereafter, which seems best suited to its particular class of work.

However, either of these alternative methods may lead to errors on special jobs requiring extra grinding, chipping, etc. It is, therefore, strongly recommended that *all* foundries carry the accounts in the cleaning, finishing and shipping departments as outlined herein as the *advanced method*, so that they may be able to figure an accurate, direct cleaning, finishing and shipping cost on any special jobs which may require it. Costs figured by either alternative method should be frequently checked by using the advanced method so that the foundry may determine how much of its work can be figured with sufficient accuracy by the alternative method, and how much *must* be figured by the advanced method to avoid serious profit leaks.

Direct Cleaning Costs (*Advanced Method*)

Tumbling, sandblasting or pickling costs are applied to individual jobs on a pound basis. However, when the foundry finds it necessary, direct cleaning costs may be determined in the manner provided for determining finishing costs, department 4 B. Sandblast cost also may be figured on a sandblast hour basis.

4-AT. Tumbling Department: The total of accounts 41-AT to 49-AT divided by the total weight of good castings tumbled gives the tumbling cost per pound.

4-AS. Sandblasting Department: The total of accounts 41-AS to 49-AS divided by the total weight of castings sandblasted gives the sandblasting cost per pound.

4-AP. Pickling Department: The total of accounts 41-AP to 49-AP divided by the total weight of castings pickled gives the pickling cost per pound.

4-B. Finishing Department: The total of accounts 42-B to 49-B gives the total finishing overhead. This total divided by *finishing direct labor* (account 41-B) gives the finishing overhead percentage. This percentage is applied to individual jobs on the basis of finishing direct labor.

4-C. Shipping Department: The total of accounts 42-C to 49-C divided by the total weight of good castings produced gives the shipping cost per pound. This cost is applied to individual jobs on a pound basis.

Alternative Methods for Determining Cleaning Costs

The total cost of the cleaning and shipping department, the total of all accounts from 40 to 49, is combined into one total amount for the month.

Molding Labor Basis (Runge Method)

The total cleaning and shipping cost is divided by the total *molding direct labor* (account 21) which gives the cleaning and shipping overhead percentage. This percentage is applied to individual jobs on the basis of molding direct labor.

Tonnage Basis (Klaus Method)

The total cleaning and shipping cost is divided by the total weight of *direct labor* (account 21) which gives the cleaning and shipping cost per pound. This cost is applied to individual jobs on a pound basis.

Distribution of Department Overhead in Auxiliary Departments

The following covers the procedure when the auxiliary departments are used:

5. Carpenter Shop

The total of all accounts from 53 to 59 is divided by the time charged to account 51, *direct labor carpenter shop*, which gives the overhead percentage. This percentage is applied to individual jobs on the basis of direct carpenter labor. The total cost of each job is then charged either to a department repair account (17, 27, etc.) to flasks (25), or to general repairs (133).

6. Pattern Shop

The total of all accounts from 62 to 69 is divided by the time charged to account 61, *direct labor pattern shop*, which gives the overhead percentage. This percentage is applied to the individual jobs on the basis of direct patternmaking labor. The total cost of each job is then charged either direct to customer or to patterns (26).

7. Maintenance Department

The total of all accounts from 73 to 79 is divided by the time charged to account 71, *direct labor maintenance department*, which gives the overhead percentage. This percentage is applied to individual jobs on the basis of direct repair labor. The total cost of each job is then charged either to a department repair account (17, 27, etc.) or to general repairs (133).

8. Heat, Light and Power Department

The total of accounts 80 to 89 is divided between and charged to account 120, heat, and account 121, light and power, in proportion to the relative expenses thereof.

Scope of the Standard Cost System

It is not intentional and it is not believed possible to design a system of cost accounting which would apply in every minor detail to every gray iron foundry in the United States and Canada. It is thought possible, and very desirable, that every gray iron foundry, in its cost accounting practice, should conform to the fundamental features of this standard cost system, which are:

1. The classification of departments and subdepartments, if subdepartments are used.

2. The classification and definition of accounts. Every ordinary operation in the production of gray iron castings, and every ordinary expense incidental to production has been classified and allocated to some definite account and department. In every department some accounts have been reserved for special items or further subdivisions when required. All gray iron foundries can observe these classifications. No item of overhead expense mentioned can be omitted if a true cost is to be obtained.

3. Accurate time keeping to get a correct distribution of direct labor to the individual job is essential in the molding and coremaking departments. In the cleaning and finishing department the necessity for direct labor time keeping is left to the individual foundry to determine.

4. The method of distributing general and departmental overhead is a fundamental feature of this standard cost system. It is essential that all gray iron foundries should use the same uniform method of distributing overhead in arriving at cost figures used in quoting prices on prospective business. Only by this means can competition be put on a sound and legitimate basis.

The above features are fundamental. In regard to the remaining details of purely accounting routine, we believe that it is advisable to leave them to the individual foundry to work out for itself. A good foundry executive should have, or should acquire, a working knowledge of the principles of cost accounting. A good foundry bookkeeper should be familiar with general accounting and cost accounting routine, and should be able to adapt this standard cost system to his own particular foundry. The institute office will be pleased to further explain any features which are not clearly understood.

The maximum benefit will be obtained, however, by securing the assistance of some consulting foundry cost accountant who is thoroughly familiar with the standard cost system, and who has had actual experience operating it in other gray iron foundries.

Accounting for Labor

The method of collecting labor data for the cost accounting records is extremely important. Unless it is performed with accuracy and ease the results are unreliable and misleading. Since the cost of individual castings is dependent largely on correct labor costs, it is evident that incorrect labor data may lead to disastrous cost figures. The labor data for the various accounts given in the standard classification of cost accounts are obtained from the records used for distributing the time, that is, the classification of labor according to the nature of the work. Data for employes on a salary basis are obtained from the salary payroll.

Accounting for Materials, Supplies, and Other Charges

Data pertaining to the cost of materials, supplies and other charges are obtained from heat reports, monthly inventories, stores' requisitions, voucher records, reserve accounts in the cost ledger, etc. It is important that these charges be classified correctly and applied to the proper cost accounts.

Inventories

Monthly inventories must be taken in order that a monthly profit and loss statement can be obtained.

Good Castings Produced

The weight of good castings produced is obtained by adding to the weight of good castings on hand at the end of the month the weight of castings shipped during the month and deducting the weight of good castings on hand at the beginning of the month.

Shop Scrap

A careful record of all castings scrapped before shipment should be kept, to keep this loss down to a minimum. No account number is provided for shop scrap, since tonnage costs are figured on the basis of good castings produced. If scrap losses increase, the amount of good castings produced will be less, and tonnage costs will be increased.

Defective Castings Returned

The cost of defective castings returned by customers is charged to account 190, *deductions from sales-defective castings returned*, and is not included in general overhead. After the cost of any individual job has been arrived at by using normal direct and overhead rates, a percentage should be added to cover the actual loss in that particular job, as near as it can be estimated or determined. If the cost of all defective castings returned was included in general expense, this cost would be spread evenly over all jobs, whether the actual loss was 5 per cent or 20 per cent. It is, therefore, more equitable for each job to stand the actual loss thereon, as above recommended.

Trucking, Freight and Express Out

Complete cost figures determined by this cost system, including an estimated percentage for profits and loss, represent the cost f.o.b. foundry. When delivery is made from the shipping platform to local customers or to freight cars, the delivery charge must be added to get the total cost. Deliveries by the company's trucks should be determined as accurately as possible on a cost per pound basis for various destinations, local or distant. If shipped by freight or express the particular job should be charged with the actual shipping costs.

Depreciation

Depreciation of plant and equipment must be charged into current costs of production as it is an item of expense. The need of charging depreciation to current costs arises from the fact that working assets gradually give out or become obsolete; in other words, they are used up in production, and the cost of this usage or consumption is part of the cost of the product being manufactured.

The test for determining the percentage of depreciation is the estimated life of the equipment. Buildings are subjected to similar depreciation, but the estimated life is usually much longer.

This charge to costs for depreciation cannot be abandoned simply because profits are nonexistent, for depreciation accrues whether or not there is a dollar of profit. It is preferable that depreciation be accumulated in a depreciation reserve account, charging costs of production each month and crediting the depreciation reserve account in the ledger. This reserve is directly affected when renewals are made and when the property is exchanged, sold, replaced, or abandoned.

Interest on Investment

It is the practice in many foundries to carry the interest on investment (at a rate of 6 per cent annually) as an item of overhead expense. This practice is general in many sections of the country. That interest is a legitimate item of costs and should be included therein, just as rent, when incurred, is a proper charge to costs. However, it should be noted, that in preparing income tax returns interest on investment is not an allowable deduction.

Capital and Revenue Expenditures

When new equipment is purchased, and when old equipment is replaced, major items are charged to capital accounts, and a percentage for depreciation is charged into costs each month. In the purchase of minor items, such as small tools, etc., the whole cost is charged directly to expense in the month in which the purchase was made. In doubtful cases, the safest policy is to charge the whole cost directly to expense.

Operating Reserves

Operating reserves measure the cost of operations which, while not necessarily expended at the time, will positively be incurred according to past experience. The following reserve accounts are recommended:

Reserved for Depreciation: A definite amount is charged each month to manufacturing costs, under general overhead, accounts 112 and 113, and the same amount is credited to the reserve for depreciation account in the ledger. (Note the paragraph on depreciation.)

Reserved for Doubtful Accounts: A definite percentage of total casting sales or a definite amount per ton of good castings, is charged to costs each month in account 158, loss from bad debts, and the same amount is credited to the reserve account in the ledger. As bad debts occur they are charged to the reserve account in the ledger.

In addition to the above which represent the major items to be handled as reserves, there are others such as the following which may be taken care of in the same manner: Reserved for cupola relining; reserved for flasks; reserved for loss of defective castings after shipment; reserved for inventory adjustments; reserved for taxes and insurance.

Normal Overheads

It is quite apparent that in a foundry which normally produces 200 tons per month, the fixed charges and general expense will remain about the same whether production is 100 tons per month or 300 tons per month. Naturally, when production is low, the actual overhead percentages will be higher than when the production is high.

In estimating work, it is generally the standard practice to use so-called normal overhead percentages, that is, overhead percentages arrived at by using the cost figures of a normal year. Ordinarily the actual overhead percentages for the previous year are used, unless it was an abnormal year. Normal production for establishing normal overhead percentages is generally considered to be about 70 per cent of capacity. In estimating, the

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Each Foreman Became a Secret Convert To Apprenticeship Training

And Soon Had Several Boys Quietly at Work in Their Departments

Let Apprentices SELL APPRENTICESHIP

By C. J. FREUND

MUCH excitement was in evidence at the plant of the Cunningham Foundry Co. Work went on as usual but there was a great distraction in the minds of the molders and coremakers as well as the foremen in the place. During the noon hour instead of sitting in a row along the wall complacently disposing of their lunch, the men hardly took time to eat and stood in groups holding violent discussions. The general foreman frequently went into the locker room during working hours to break up conferences and there was much gesticulating as the men left for home at night.

The excitement was caused by a rumor that the organization would merge or sell out. But the rumor could not be confirmed. When would the merger take place? What other foundry was involved in the arrangement? Nobody knew. Countless suggestions were made but none was generally accepted. Nevertheless, the rumor persisted, as rumors will.

Perhaps the rumor persisted because it was logical that a change should be made. The foundry was owned by three brothers, all well up in the seventies. They were kindly, courteous gentlemen who had worked hard and intelligently in their day and at one time had made a lot of money and had been leading foundrymen in their district. Of late years, however, they had been unable to keep step with the progress of the times. The business was undoubtedly stable but sand was still mixed by shovel much of the time and wheeled about the floor while two or three bookkeepers sat on high stools in the old fashioned office and tried in vain to cope with the cost situation. Matters could not go on as they were and no one knew it better than the owners themselves.

The excitement was not mitigated when the three owners of the business walked slowly through every department of the foundry one day accompanied by a group of solemn looking individuals with a high percentage of derby hats and spectacles. "I'll bet it's the new board of directors," someone suggested and the question instantly spread through the shop. A week later a notice was posted on all bulletin boards that the Cunningham Foundry Co. had been sold to the National Foundry Corp. and that the organization would remain intact except for the chief officers.

The next noon hour the foremen were in the lunch room where they remained every day after their meal for an informal discussion of matters pertaining to the foundry, and many other matters besides. Perkins, foreman in the heavy work department, was speaking.

"There is another thing to think about. We all keep our jobs but that don't mean there won't be a lot of new fangled monkey business saddled on us by the new management. For one thing, we're sure to get apprentices. This National Foundry outfit is hot about the idea. I don't like it much; I have trouble enough as it is."

While he spoke Larson, the core room foreman leaned forward eagerly. He could hardly wait for Perkins to finish. He was a big, lumbering,

slow-moving, slow-thinking fellow, essentially conservative. He seldom spoke unless thoroughly aroused but he was aroused now and his deep full voice filled the room.

"I don't know much about this apprentice business but it seems to be the style. There is a lot about it in THE FOUNDRY and there are always a couple of chaps rattling away about it at the conventions. They make me tired with always changing, changing, changing. Nothing is ever good enough. We ain't used to one new stunt before another one comes along. The employment department was to do away forever with all this trouble about getting men and before we're used to that we catch this apprenticeship thing. I say nothing doing."

Teachers Have Hands Full

There was a murmur of assent and Peters, one of the foremen in the middle bay, added, "I don't see how a fellow can get out his work and take care of a bunch of kids besides. Teachers seem to have their hands full with them and they don't have scrap and production to worry about."

There was a moment's silence. "None of us are keen about apprentices," spoke up Dietrich, who often functioned as spokesman for the group, "but we won't have much to say when the new boss comes in. Maybe they will respect our ideas if we all hang together and if they see that we all feel the same way about it. I wouldn't be afraid to tell the new boss, when he comes, that we aren't interested in apprentices."

The whistle blew while he was speaking but before the men had left the room and gone to their various departments they were agreed that they would protest as vigorously as circumstances permitted against any attempt to introduce apprenticeship.

A few days later, a tall thin man about 45 years of age, gray haired and somewhat dignified in appearance spent the entire afternoon with the general foreman in the latter's office and it was understood about the plant that he was the new works manager. During the first few weeks he took no active part in running the shop. He was there every day but merely observed the work and had little to say. Many weeks passed before he even went so far as to order the windows washed, odd corners cleaned up and the shop straightened away generally. Gradually a number of radical changes were made. Sand mills and mixing machines were installed, the old bumpers were discarded and a battery of modern molding machines were put into operation, the sandblast was rebuilt, a cost system installed and sand was tested by modern equipment instead of by the feel of the hand. As the changes were made the works manager entered more actively into the work and assumed the role of an energetic leader.

He became much interested in the noon hour meetings of the foremen and converted the Wednesday session into a formal conference over which he himself presided and which provided an opportunity for the foremen to express their opinions and to make suggestions. The subject of apprenticeship had never been mentioned by the works manager or anyone else.

One Wednesday noon it was brought up rather suddenly by Dietrich.

"There is one subject we have never talked about," he ventured.

"What is it?" the works manager asked, turning toward him.

"Apprenticeship," Dietrich answered bluntly.

"Oh," replied the works manager with arched eyebrows, "well, what of it?"

"We heard," explained Dietrich blushing furiously, "that the National Foundry Corp. makes apprenticeship a policy. None of us here like the idea much."

"So I understood from what I have seen and heard," the works manager said complacently enough. "The corporation believes in apprenticeship but not to the extent of forcing it upon any department head. None of you will ever be required to put on apprentices against your will."

A feeling of relief and satisfaction came over the men. There was a general brightening of faces and an almost imperceptible exchange of glances.

Rapid Progress Was Made By the Apprentice

Less than a year after the new works manager arrived, an opportunity arose for Haneman, one of the molder foremen, to become a superintendent in another organization and a tall, broad shouldered, energetic stranger took his place. Although there was no outward indication of it, the other foremen suspected that he had been associated with the works manager before, and the suspicion could have been verified. His name was Tooey and he soon won over his associates by his modesty, his friendliness and his unfailing good humor.

Not long after, the works manager, the employment manager and this new foreman met on a Sunday afternoon in the works manager's office. Had one stood near the door, one might have heard the works manager speaking.

Establish the Foundation

"You know how I feel about apprenticeship. It is an absolute necessity if the foundry industry is to prosper. The industry cannot ultimately survive if no systematic efforts are made to train young men. However, our foremen are opposed to the plan and I can't blame them as they have had no contact with apprenticeship. No amount of arguing will do any good but I know from experience that one or two apprentices, quietly slipped into the shop, can win over the entire organization.

"I have promised the foremen that I shall never require them to put on apprentices against their will. My plan is this. We shall get hold of a good boy, indenture him and put him to work with Tooey in the outward character of a regular employe. When he has had a good foundation we shall make use of our wits and circumstances as they arise to sell the boy to the foremen and with him the idea of apprentice training."

Within two weeks a 17-year-old boy began work in Tooey's department. He had been selected carefully, was strong and tall, worked hard, was ambitious, intensely interested in his work and smart and tactful enough to get on with all the men. He was taken into the works manager's confidence to this extent that he was told that for good reasons his identity as an apprentice could not be divulged for the time being. Arrangements were made with local school authorities to give

him several hours of instruction per week in mathematics and science and a correspondence course in foundry technology was provided for him. After he had been a molder's helper four months, Tooey gave him a pattern to work up and he did the piece exceedingly well. At this time a contract of apprenticeship between him and the corporation was made out and thereafter he made such rapid progress that he attracted the favorable attention of all the foremen who envied Tooey for having such a fine young workman.

Makes a New Convert

For many months following the reorganization the men were subject to the turmoil and excitement which radical changes always create among those who have been long set in their ways. Larson, the coreroom foreman was particularly afflicted for some reason. His men became fidgety and discontented. Every day he had arguments on his hands, there were quarrels among the men and some of the best of them had gone. Although he had had many years of experience in handling men and kept his head and control of the situation, he was plainly troubled. He was not the type of man who would desire to shed responsibility in the matter but he had the good sense to discuss his problems at regular intervals with the works manager.

The two were sitting together in the works manager's office. They had just gone over the entire situation again. Both felt that the subject had been covered and there was a moment's pause.

"You know," Larson said musingly, "lots of times I think it would be wonderful to have a department made up of men like that young fellow of Tooey's. Everybody is watching him and we all think he is a high class chap. Wouldn't it be fine if the shop were full of the likes of him?"

The works manager saw an opportunity to make a convert.

"I don't want to take any credit away from the young man but I honestly believe that his ability is not so much natural as developed. When we hired him he was just an average young fellow with a good character. It is more the way he has been handled than anything else that has made him what he is."

"The way he was handled?" Larson asked in surprise. "How was he handled any different than any other young fellow in the shop?"

"Let me tell you something," replied the works manager quietly. "When I first came here I told you fellows that I would never force any of you to put on apprentices but I never said that I would permit none in the shop. Tooey was used to apprentices so I told him to put one on but to keep it quiet because I didn't want the rest of you to feel that I was trying to put something over on you. That lad is an apprentice and properly indentured as one. He has been carefully trained in a systematic manner and will soon be an important member of this organization. He is an excellent example of the difference in results between haphazard and organized instruction."

Larson was too amazed to reply for a time. When he spoke, he spoke slowly. "And I used to think that apprentice training was nothing but bunk and new fangled foolishness. There must be something in it if it can make that much of a difference in an ordinary kid. I'll have to talk to Tooey; might even try the thing myself."

When Larson had closed the door on his way out the works manager smiled one of his rare, queer little smiles.

A Difficult Job

Less than a year later an extremely difficult valve chest was given Dietrich to make. It was a challenge to the imagination. There was a multiplicity of loose parts on the pattern and no end of ports and angular passages which required many complicated cores. There were 150 on the order and one was to be delivered every day. Dietrich scratched his head for hours over the blue prints and the pattern but his troubles did not really begin until the job was out on the floor. He gave the pattern to one of his best men and stayed with him during all of the first day and most of the second. On the third day he left him alone but the molder asked him countless questions and finally scrapped the casting. The work was clearly too difficult for him. Things went from bad to worse and finally Dietrich spent the best part of each day setting the cores himself while his department was neglected to get the valve chests out.

The works manager saw an opportunity in the situation and called Tooey.

"Can that apprentice of yours set those cores?" he asked him.

"I don't know," he answered, "I had better take a look and see."

That afternoon Tooey stopped beside Dietrich who had become tired and irritable. He was bent over the complicated drag adjusting one of the many cores.

"Quite a job, isn't it?" asked Tooey.

"I wish I were rid of it," Dietrich replied without looking up. "One of my best men can't make it alone. He is afraid of it and all of my explaining didn't help him a bit."

Tooey watched him long and thoughtfully and then suggested cautiously, "I think I have a man who can do that job. Suppose I send him over. I can spare him. He couldn't make it right away but he could pick it up in a hurry."

Dietrich stopped work, his face radiant with expectancy. "Who's the guy?" he asked breathlessly.

"I'll send him over in the morning."

Dietrich expected a middle aged man and could hardly believe his eyes when the boy appeared.

"Is that the fellow?" he asked Tooey before putting him to work.

"It sure is; he can make that mold."

By no means convinced, Dietrich carefully went over the job with the young man and explained the setting of each core in turn, and its proper venting and fastening. He worked with the boy for two days and on the third day the young man amazed him by declining assistance and when he inspected the mold before it was closed up he could discover no defect in the work. Needless to say, the apprentice finished the entire order.

In the meantime, Tooey conferred quietly with the works manager and one morning visited Dietrich again and the two watched the boy at work.

Enthusiastic Reception

"That chap is the best young foundryman I ever saw," Dietrich exclaimed enthusiastically. "What in sam hill did you do to him?"

"I didn't do anything in particular, only handled him the only way a young fellow in a foundry ought to be handled."

"What do you mean?" asked Dietrich sharply.

"Well, I'll tell you but keep it to yourself. That young fellow is an apprentice, a regularly identured foundry apprentice. We kept this quiet because you fellows didn't believe in the system. You can't expect young men to fall all over themselves just for a job in a foundry; you got to teach them the business."

During the next hour or two Dietrich did some of the hardest thinking of his life. Thereafter he went to see the works manager and told him he was interested in apprenticeship and would like to have more information. The works manager gave him some books and pamphlets and

when he had gone he stood in the window of his office and smiled.

In this manner one foreman after another became a secret convert to the cause of apprenticeship and soon most of them had one or two apprentices quietly at work in their departments.

One of the last to get into line was Perkins who had charge of the heavy work. In his department castings weighing many tons were made in huge flasks and pits. His men required the greatest molding skill. They worked for days and weeks in the preparation of molds for turbine cylinders, condenser parts, plates for powerful presses, side frames for excavating machinery and similar pieces. The best mechanics in the shop worked in this department and Perkins devoted more time than any other foreman to the instruction of his men. This was thankless work and he frequently complained of it. After weeks of attention to a promising young man, he would leave just at a time when Perkins' efforts began to bear fruit. One day he and the works manager were watching some bungling on a big housing in a pit and Perkins apologized for the man.

Trained Men Leave

"He is a new man, he has only been here a few weeks. He molded somewhere else but that doesn't help much on this stuff. I have a hard time. I work my fool head off breaking a man in and as soon as I get anywhere, away he goes. I've tried more young fellows than older men. Kelly had most of my time for weeks on end and got to be pretty good when he quit to go into a tool shop with his brother. I worked over Hendricks for months like he were my son and now he's gone. Peterson was here a year. I showed him everything I knew, answered his questions, explained, demonstrated, sweated. Then he went. It was the same with Jordan, Trexler, Geraty, Bonner, Toole, Siever and a dozen others who've gone away and taken with them the best I had in time and ideas."

"Wouldn't it be a fine thing if those fellows could be held here by some kind of a contract?" the works manager suggested dryly.

"You bet it would," agreed Perkins, laughing at what appeared to him to be an impossibility.

"Tooey, Dietrich, Larson and some of the other foremen seem to have better luck with their young fellows," the works manager continued.

"Yes, sometimes I wonder how they do it."

"They sign them up on a contract just as I said."

"On a contract, what kind of a contract?"

"An apprenticeship contract."

"I thought we weren't going to have apprentices in this shop," Perkins protested.

"We were to have them only if the men wanted them. All these fellows asked for apprentices of their own free will."

And so the two men talked forty minutes, an hour, an hour and a half. When they finally separated, Perkins' face looked as if he were inspired by a great idea and the works manager was smiling one of his rare, queer little smiles.

In another eight months there were a dozen boys in training in the shop and every important foreman felt that apprenticeship was practically if not yet officially a policy of the plant. Accordingly, many of the noon hour discussions were now devoted to ways and means for making apprentice training an established part of the business of the plant.

The subject was introduced at a formal noon meeting by Dietrich who requested on behalf of his fellows that an apprentice department be established and that apprentice training be officially recognized by the corporation. The works manager was obviously much pleased and appointed Dietrich, Tooey, Perkins and Larson members of a committee to plan the organization.

"We have a peculiar situation in our plant in that apprentice training was well under way before a committee or department was organized. Usually it is the other way, which is undoubtedly more logical. I have always maintained that apprentices can put over apprenticeship better than anyone else but I have never seen my theory work out in so striking a way as it has in this shop."

This is the first of two articles by Mr. Fruend in which he presents information on the subject of apprentice training. The second will appear in an early issue.

—THE EDITORS.

Brass Foundry Practice

(*Concluded from Page* 75)

and the carbon is thrown out of solution as graphite. Any nitride present, also is thrown out similarly as indicated by the evolution of ammonia when sodium hydroxide is added to the cooled powder. This is one way in which nitrogen can be fixed.

A third hypothesis to account for the manner in which molten metals solidify is the one evolved by Professor Quincke of Heidelburg, whose idea was that metals at the point of solidification separate into two immiscible liquids. One of these is much lesser in quantity than the second liquid, and presumably of higher melting point, for it forms a foam or a mass of bubbles as soapy water does when agitated, only the water bubbles inclose air, while the metal bubbles inclose the second separation of the metal, forming the bulk of the alloy. This hypothesis was investigated by Prof. Cecil H. Desch, Royal Technical college, Glasgow, in his second report of the Beilby prize committee, of the Institute of Metals, which appeared in the *Journal* of the Institute of Metals, Vol. 22, No. 2, 1919.

Prof. Desch believed that evidence had been obtained in support of the theory, although not conclusively. In commenting on the report, Dr. Zay Jeffries, Cleveland, stated that he felt that the investigation was to determine or ascertain whether the solidification of the primary grains proceeded from the outer walls of the cell, and solidified inwards, or began at the center and proceeded outwards, as in the case of the first mentioned theory in this article. It was the belief of Dr. Jeffries that if the solidification was from the outer boundaries of the crystals, that, due to the crystalline shrinkage of all metals, except bismuth, this would demand that a cavity be left in the center of each grain, whereas no such cavities existed. Instead, the microscope showed cavities along the grain boundaries instead of in the crystal.

Book Review

Popular Research Narratives, Volume III, cloth, 5 x 7½ inches, collected by the Engineering Foundation. New York; published by the Williams & Wilkins Co., Baltimore, and supplied by THE FOUNDRY, Cleveland, for $1 plus 15 cents postage, and by the Penton Publishing Co. Ltd., 416-17 Caxton House, Westminster, London, for 6s, postpaid.

Scientific research is the backbone of modern industrial development and the source of many every day necessities and luxuries. It is responsible for the automobile, the telephone, the airplane, the radio, the great airship, artificial silk and innumerable other achievements of present day civilization. Research laboratories of industry, universities and special groups, constantly are working to solve countless problems, which, in the end, will benefit all mankind.

This volume, which is the third of a series, is made up of 50 brief stories of research, invention and discovery, written for the most part by the men engaged in the developments described. The narratives have been collected by the Engineering foundation, an institution of men and funds organized to

make the riches of nature useful to men, through research. Many of the stories are well written and cover a wide range of subjects. The foundryman may find direct application in a few of the narratives discussing such subjects as cast iron pipe, electrolytic iron, grinding, chromium, etc. Other articles, covering subjects from the distances between stars to the roasting of ores should prove interesting reading.

Closeness of the authors to the particular development described, possibly may have prevented the presentation of all sides to some of the questions. For example, in one article headed "Another Evolution, Electric Welding and Flame Cutting Revolutionize the Building of Machines," the author leaves the impression that the production of castings for large machines is a slow, tedious and expensive job, with disaster waiting at the end, while welded structures may be slapped together in no time after the drawings come from the drafting room, at little expense for labor and no appreciable charge for overhead. The reader is led to believe that castings are unsatisfactory parts for machines and that science and engineering has provided an escape. Visitors at the recent machine tool show in Cleveland, where thousands of dollars worth of precision machines, constructed of castings were shown, might wonder who is crying for this *escape*. The value of castings was clearly shown at that exhibit.

Birmingham Branch of I. B. F. Meets

DURING the annual dinner of the Birmingham, Coventry and West Midlands branch of the Institute of British Foundrymen, held Jan. 18, interesting references to last summer's visit of American foundrymen to England were made.

Alderman W. Byng Kenrick, deputy lord mayor of Birmingham, proposed the principal toast, and spoke of the question of the interchange of knowledge in various industries or arts. He remarked that it was only with the dying out of the nineteenth century and its traditions that one began to find the establishment of institutes or associations of those engaged in a trade. These were started definitely with the idea of what their ancestors would have called *swapping* trade secrets, a thing that earlier would have been considered inconceivable and quite immoral. The originators of the Institute of British Foundrymen about the close of the nineteenth century got together with the idea that there was some good to be done by getting together and bringing into common pool their experiences and discoveries. Having completed a quarter of a century of existence, Alderman Kenrick said he would like to congratulate the institute on its progenitors and on having maintained and developed the tradition they established. Conditions in the foundry trade had been rapidly changing. There had been a great development in regard to the varieties of metals used and their combination, but progress would not have been so rapid if they had not been willing to come together, to compare experience and help one another. In that way they had not only benefited themselves, but they benefited the nation as a whole.

The world-old struggle between those who worked with the forge and anvil and those who handled the cupola and mold always would exist. However, at the moment one would say that the manipulator of pressed steel, drop forgings and hot pressed metal industries, and so forth, had hit hard in the foundry trade. Yet somehow he thought they were arranging a *comeback*, as their American friends would say, developing fresh fields, which would be entirely their own until the next abominable inventor, working with a hammer and anvil, came back again.

E. H. Tyson, the branch president, referred to the greetings which had been received from the American Foundrymen's association delegation and suggested the members should reciprocate by signing the menu card.

President Lambert Responds

Wesley Lambert, responding to the toast of "The Institute," recalled with cordial appreciation the fact that the institute was founded in Birmingham. Its aim and object was the nonpolitical furtherance of the foundry industry and the dissemination of technical knowledge appertaining to the industry. Its membership now is about 2000. Every endeavor is made to see that the young foundry worker receives education in those subjects that appertain to the industry, so that Great Britain might in the future, as in the past, uphold those traditions which the craftsmanship of the foundryman so worthily typified. Over 100 technical papers will be presented during the current winter sessions, a number which probably could not be approached in Great Britain. The institute was proud of its Birmingham branch, whose members included some of the most active in the institute.

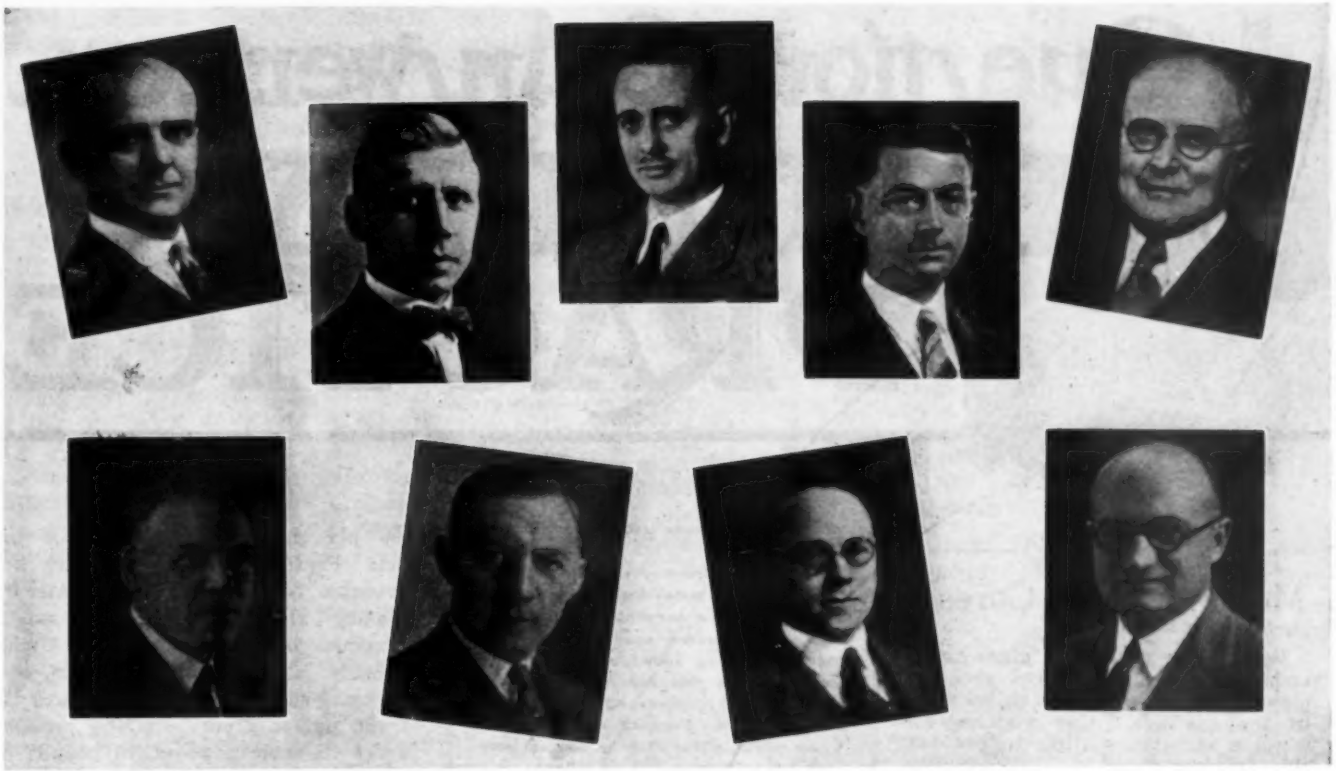
Referring to the International Foundry convention held last summer, Mr. Lambert said he had received a larger number of letters from delegates from all parts of the world who attended and they all appreciated the cordiality of the welcome they received in Great Britain.

J. Smith, South Shields, was congratulated on his recent election to the presidency of the National Ironfounding Employers' federation. Mr. Smith said they had something to be proud of in being in Birmingham, where the institute, then called the British Foundrymen's association, was started 25 years ago with 50 members. He congratulated the Birmingham branch on having 200 members and on the fact that they had a junior section. He urged that while they as members, studied the scientific side they should not forget the practical side. With both sides working harmoniously, there would be no doubt about the success of the industry.

E. H. Tyson said the membership had slightly increased during the year. With regard to the junior section, the branch members were finding it impossible to fill the gaps created by the transference of juniors to the senior section. Special propaganda work, however, was being undertaken and they hoped that by such means the junior section would be greatly strengthened. A number of members had taken an active interest in the educational schemes for the foundry apprentice in which the institute was taking a considerable part.

Safety Council To Hold Congress at Pittsburgh

The nineteenth annual meeting of the National Safety council will be held at Pittsburgh, Sept. 29 to Oct. 4. A large attendance is anticipated. An exhibition will be held in conjunction with the congress in the basements of the William Penn Hotel. The Fort Pitt and William Penn hotels have been designated as convention headquarters. A feature of the meeting will be a day designated as "Pennsylvania Day." A large attendance is anticipated at this convention. Last year over 7000 delegates attended the Chicago meeting.



Quad City Foundrymen Arranging Joint Meeting. From Left to Right, Top Row, R. L. Eichman, John Ploehn, F. W. Kirby, John Diedrich, P. T. Bancroft. Bottom Row, Charles Demmler, A. E. Hageboeck, A. D. Matheson and H. Bornstein

Quad City Group
And A. F. A. Plan Joint Meeting

A JOINT meeting of the Quad City Foundrymen's association and the American Foundrymen's association will be held at Moline, Ill., March 26. This gathering, which has been made possible through the invitation of the Quad City group, constitutes the first step in the general program of the A. F. A. for instituting closer relations with the various district foundry associations. Members of the association and other foundrymen from the entire country are invited to attend the meeting. However, the affair has been planned primarily for the interest of foundrymen in that territory surrounding the Quad Cities.

As the district has a large number of interesting foundries, it is believed that many of the visiting foundrymen from the surrounding districts will desire an opportunity to inspect some of the important gray iron, malleable and steel foundries. For that reason the entire morning will be devoted to plant visitations. The luncheon meeting, which will follow the visitation program, will consist of discussion groups on cupola practice, steel founding, malleable founding, nonferrous practice, foundry costs and gates and risers. Two interesting papers on technical subjects will be presented at the afternoon session. A banquet will be held in the evening.

The committee in charge of the local arrangements consists of the following officers and directors of the Quad City Foundrymen's association: President, F. W. Kirby, John Deere Spreader Works, East Moline, Ill.; vice president, R. L. Eichman, Bettendorf Co., Bettendorf, Iowa; secretary-treasurer, J. P. Boaden, Union Malleable Iron Co., East Moline, Ill.; directors, P. T. Bancroft, John Deere Harvester Works, East Moline, Ill.; H. Bornstein, Deere & Co., Moline, Ill.; Charles Demmler, Walworth Mfg. Co., Kewanee, Ill.; John H. Diedrich, Blackhawk Foundry & Machine Co., Davenport, Iowa; A. E. Hageboeck, Frank Foundries Corp., Moline, Ill.; John H. Ploehn, French & Hecht Inc., Davenport, Iowa, and A. D. Matheson, French & Hecht Inc., Davenport, Iowa.

John H. Ploehn is chairman of the committee on reception and arrangements, John Dietrich is chairman of the plant visitation committee, A. E. Hageboeck is chairman of the committee arranging the round table discussions, and H. Bornstein is heading the committee which is arranging the technical sessions.

Holds District Meetings

The Gray Iron institute, which is organizing local chapters throughout the country, is holding a series of meetings in the eastern district. Meetings have been held at Hotel Statler, Buffalo, Feb. 11 and Hotel Syracuse, Syracuse, N. Y., Feb. 13. Other meetings are scheduled for Hotel Penn Harris, Harrisburg, Pa., Feb. 15; Manufacturers club, Philadelphia, Feb. 18 and Lord Baltimore Hotel, Baltimore, Feb. 21 All meetings start with a luncheon at noon followed by a presentation of the various institute activities.

W. H. Bixby Inc., representative of the American Engineering Co., Philadelphia, has moved its main office from Omaha, Nebr., to 1004 Hubbell building, Des Moines, Iowa.

Questions & Answers on FOUNDRY PRACTICE

GENERAL

Molds Stick to Cores

QUESTION

Part of our product is glass house molds in which iron cores are employed. Some of these chills stick to the castings. Can you recommend a suitable coating to prevent this trouble.

ANSWER

Cast iron cores for castings designed to be used for molds in glass factories are coated in various ways, depending principally on their bulk. A light coating of oil usually is all that is necessary in molds of light section. For heavier molds the oil is mixed with plumbago and applied with a brush or a rag. The molten metal congeals almost instantly and does not fuse with the core. Where the metal section is heavy the core is covered with a thick coating of blacking, talc or silica flour mixed with molasses water. These cores are dried in the oven like any core and placed in the mold while warm so that they will not *draw* dampness.

Q & A

Limestone Is Required

QUESTION

What is the proper amount of limestone to use in a cupola? We melt from 5 to 6 tons of iron in our cupola and open the slag hole after the first 3000 pounds have been tapped.

ANSWER

The proper amount of limestone to use in a cupola is the amount that will unite with all the impurities of the charge and then flow freely through the slag hole. This ideal condition depends on so many factors that the amount cannot be set down arbitrarily as so many pounds of limestone per so many pounds of iron in the charge. Also, the proportion cannot be based on the diameter of the cupola that is being used to meet the user.

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall—Cast Steel
H. A. Schwartz—Malleable Cast Iron
J. W. Bolton—Gray Cast Iron

All questions should be addressed to The Editor, The Foundry, Penton Building, Cleveland.

The first factor to consider is the composition of the limestone available. Manifestly a high grade limestone may be used in smaller quantities than a limestone in which the fluxing elements are adulterated by large amounts of impurities. The best limestone for foundry use is practically pure carbonate of lime with the following approximate analysis: Calcium carbonate 83.00 to 99.00 per cent, magnesium carbonate, trace to 14.00 per cent, silica 0.5 to 2 per cent, alumina 0.40 to 1.50 per cent. In the foregoing it will be noted that the impurities do not run over 3.00 per cent. In blast furnace practice the limit of impurities is placed at 5.00 per cent.

The next factor of importance is the condition of the iron which is charged into the cupola. Where large quantities of gates and scrap are charged just as they come from the floor, the amount of adhering sand increases the amount of limestone required to convert it into a liquid slag. Coke with a high ash content introduces the same problem.

Under favorable conditions, machine cast pig iron, clean scrap not over 30 per cent of the mixture, a good grade of coke and with a limestone of the approximate analysis already given, the quantity need not exceed 1.00 per cent of the weight of the iron. Presence of one or more unfavorable factors may necessitate increasing this percentage up to a maximum of 20.00 per cent. Under ordinary jobbing shop conditions, dirty iron and limestone not exactly of the purest grade, common practice favors the use of about 70 pounds of limestone to each ton of iron charged. Local conditions decide the *exact* amount to use.

Q & A

Sprays Mold Face

QUESTION

What is the general practice in the use of a dry core binder. Is it added to the sand in a dry state or is it mixed with water to the consistency of a thin paste and then added. This inquiry is suggested by the practice in a steel foundry where the green sand facing dries rapidly and the edges of the mold crumble easily. The sand and binder are mixed dry in a pan muller and the necessary amount of water is added afterward. Green sand facing in molds for steel castings is worked much drier than facing sand for gray iron castings. In my opinion a binding agent added to sand in the dry state has not the same bonding power as a binder added in the shape of a thin paste. If a starchy binder is added according to this second method I believe the corners in a mold will harden on air drying. Your opinion will be appreciated on this point.

ANSWER

So far as the actual bonding power of the binding agent is concerned we are of the opinion that it is six of one and half a dozen of the other whether it is added in the form of a powder or mixed with water. Some room for doubt might exist if the facing was mixed by hand, but the manufacturers of sand mixing equipment have developed their various machines to such a high state of perfection that a thorough distribution of the bonding agent is effected whether it is wet or dry. Personal preference based

usually on early experience seems to be the deciding factor.

In many instances a practical operating factor enters into the problem and leaves no choice in the condition in which the binder is added. If all the sand was perfectly dry, then the desired amount of binder might be added either in dry or liquid form, because in either event a certain amount of water would have to be added afterward to render the sand workable. Where damp sand is employed the desired amount of dry binder may be added, but it is quite within the range of possibility that if the desired amount of binder be added diluted with water, the resulting sand will be too wet. Any practical foundryman knows that it is much easier to add water to sand than to take it out.

Spraying the face of the mold with molasses water or with a thin solution of any core binder will strengthen the corners and other exposed points which show a tendency to dry and crumble away. Also this practice will assist in securing a better surface on the resulting casting.

GRAY IRON

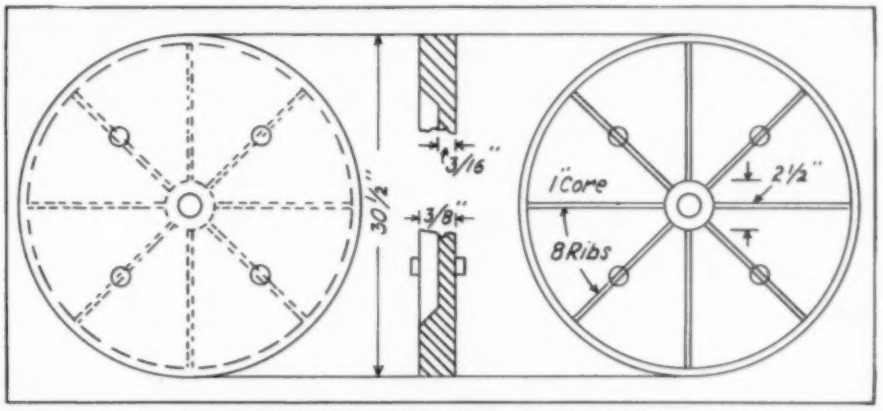
Round Plate Is Warped

QUESTION

The attached sketch shows a round cast iron plate 30½ inches diameter, 3/16 inch thick with eight light radial ribs and a light bead or rib around the circumference on the same side as the ribs. We have molded this casting according to several methods, but none of the castings is true. We have left the casting in the mold over night, but when it was removed from the mold in the morning, it sprang out of shape. We shall appreciate greatly any suggestion that will assist us in securing a flat plate.

ANSWER

You do not give any detail of the different methods you have tried, therefore we are at a loss to determine the exact cause responsible for the warped casting. The fault may lie with the flask, the sand, the ramming, the force with which the metal is poured, or with the shape and location of the runners and gates. Any one, or, a combination of two or more of these factors may lie at the root of your trouble. The most probable cause is an uneven thickness of metal in the casting, with the greatest thickness in the center. As a result the center cools last and springs the remainder of the plate out of shape. This extra thickness in the center may be due to a sag in the drag in rolling the mold over, to a soft drag that sinks under the weight of the metal, or to a weak cope that springs in the center from the same cause. A 30-inch diameter plate under a 6-inch head of metal exerts a pressure of 1110 pounds against the face of the cope. To satisfy yourself on this point, break one of the defective castings and note the difference in thickness. You may be driving the metal into the mold with unnecessary force and thus straining a mold which under more favorable pouring conditions might turn out a satisfactory casting. You may be pouring it in a manner that sets up unequal cooling strains. Bearing the foregoing features in mind the following procedure should be followed. Select a good, stiff flask. Cast iron or steel is best, but a wood flask may be used if treated with proper precaution. The sand should be rammed firmly, the bottom board adjusted properly and the drag should be rolled over on to a level, firm bearing, preferably a concrete floor. Pour the casting with four hand ladles through runners in the four corners of the flask and with each runner feeding several thin, branch gates. In this manner the mold will receive metal simultaneously from all around the circumference. Naturally the center of the plate will cool last, but by this distribution of gates around the rim, the cooling speed will be approximately equalized over the entire plate. Break the runners immediately after they have solidified and leave the plate in the mold until it is cold. Clamp a rail across the top of the cope and wedge the bars down.



UNLESS THE COPE IS UNUSUALLY STRONG THE CASTING PROBABLY WILL STRAIN IN THE CENTER

Q & A

Analysis Is Not All

QUESTION

We are operating our foundry almost exclusively on bench work and largely on light work running less than ¼-inch thick although occasionally we run as high as 2 inches thick. We believe that we have a good analysis for the purpose which is as follows: Silicon, 2.32 per cent; manganese, 0.64 per cent; phosphorus, 0.58 per cent; sulphur, 0.068 per cent; graphitic carbon, 3.02 per cent, and combined carbon, 0.52 per cent. We are using a by-product coke which has reduced our sulphur materially. Our castings must be smooth and have sharp edges suitable for lacquering, etc. We are trying to get the manganese around 0.60 per cent and the phosphorus around 0.40 per cent. We have been told that if the sulphur is reduced below 0.09 per cent every point saved will warrant a reduction in silicon of 0.15 per cent. We also have been told that manganese over 0.60 per cent has a tendency to chill the surface of light castings, and that phosphorus formerly regarded as of great value in getting close-grained stove castings is considered a scavenger that can be dispensed with although the tendency is to hold it between 0.20 and 0.40 per cent.

ANSWER

Since your work is light, it would come within the classification known as stove plate, and we believe that your anaylsis is excellent for the purpose. However, you should be a better judge of that than we can be without seeing the castings. The analysis alone does not tell the whole story, as much depends on the material used in the charges. If you use a large amount of scrap, results obtained from a given analysis would not be the same as when using small amounts.

However, from the analysis given, we are of the opinion that you are using small amounts of scrap in the charge, as indicated by your low sulphur. If your iron is soft enough for drilling and machine work, it undoubtedly meets the customer's approval. If your castings are too soft, you could reduce the silicon by degrees until the desired closing up of the structure is obtained. Proceed with caution however, as with thin work you may get castings that will be harder to machine, and result in complaints from the machine shop.

High sulphur is supposed to harden cast iron, but many investigators believe that the hardening is caused by oxidation because high sulphur

iron generally is associated with poor cupola practice. Moldenke states that hardening attributed to sulphur may be counteracted by allowing 0.10 per cent silicon for every 0.01 per cent sulphur expected above the normal which he places from 0.08 to 0.100 per cent. However, whether the silicon may be reduced on the same basis when the sulphur drops is another story. Cast iron at best is a complicated alloy due to the number of elements that compose it, and the effect of each must be considered. Hurst states that sulphur up to 0.200 per cent in castings containing 2 per cent silicon does not exert any serious influence on graphitization. Therefore, we doubt that you could reduce the silicon on a basis of sulphur reduction.

Manganese promotes the absorption of carbon and promotes fluidity by increasing the solidification range. Hague and Turner found that even small quantities of manganese increased the graphite content, and Coe found that with cast iron containing 2.48 per cent silicon, 3.80 per cent total carbon, and 4.19 per cent manganese, that the combined carbon only reached 0.86 per cent. This would make the iron hard for many purposes, but not excessively so. With a cast iron containing 2.35 per cent silicon, 2.65 per cent manganese and 3.60 per cent total carbon, Coe found the combined carbon to be 0.27 per cent. You can see from these examples that manganese is far from being a hardener. However, we suggest that you keep your manganese content under 1 per cent.

Phosphorus in days past was considered necessary to give the fluidity required for running thin complicated castings. At the present time the tendency is to hold the phosphorus as low as possible with the irons at hand. If you can reduce it to around 0.30 per cent so much the better. The iron must be poured hot to make up for the lack of the slow freezing phosphorus eutectic which promotes fluidity, and often is the cause of brittleness, segregation and hard spots that are found in gray iron castings.

Q & A

Wheel Hub Is Too Hard

QUESTION

We are enclosing a blueprint of a small mine car wheel that is causing us considerable trouble. The upper end of the hub chills around the core so that it cannot be machined. Estimated analysis of the iron is silicon 0.91 per cent, sulphur 0.06 per cent, phosphorus 0.35 per cent, manganese 0.63 per cent. The charge is made up from malleable bessemer pig 50 per cent, charcoal iron 20 per cent, steel scrap 10 per cent and scrap mine car wheels 20 per cent. The cupola is lined to 36 inches. We place 800 pounds of coke on the bed and 100 pounds between the 1000-pound iron charges. The blower delivers 2800 cubic feet of air per minute.

ANSWER

Assuming that the character of the iron is satisfactory in every other particular it is apparent that the chill around the top of the hub next the core is the result of some local cause. You do not state what style of runner is employed and that introduces an element of doubt into a long distance diagnosis. The first and most obvious remedy, is to heat the mold and core around the top of the hub.

The heating is accomplished by pouring the metal through a covering core set over the center core in the hub. Instead of one or two gate openings, an almost continuous ring of small pop gates should be provided. This will serve the double purpose of insuring clean hubs and of heating the sand around the top of the hub and thus prevent the iron from chilling.

The trouble may be due to the iron mixture or to the manner in which the wheels are annealed. You may find it necessary to raise the silicon content either by the addition of ferrosilicon or by the omission of steel scrap in the charge. A little more speed in getting the wheels into the pits might cure the trouble. However, we are inclined to the opinion that the gating system is responsible, and we suggest you try the remedy outlined first. If no relief is obtained try some of the other suggestions.

STEEL

Mixes Facing Sand

QUESTION

We understand that bentonite is used for making facing sand for steel castings with good results. Have you any information on the subject?

ANSWER

A number of steel foundries are using bentonite for facing sand with good results, and some are using it for both facing and backing sand. One large steel foundry uses the following mixtures for light castings and heavier castings respectively: 400 quarts of moist new silica sand; 12 quarts of bentonite; 10 quarts of silica flour, and 2 quarts of dextrine. For heavier castings the mixture consists of 30 shovels of new moist silica sand; 10 shovels of washed and dried silica sand; 3 shovels of silica flour; 2 quarts of dextrine and 26 pounds of bentonite. Since the backing sand usually does not require as much bond as the facing sand the amount of bentonite may be reduced. Components of the facing sand should be mixed in some kind of a mixing device to obtain the best results.

MALLEABLE

Makes Quality Malleable

QUESTION

What are the best and latest methods used in making malleable cast iron? Are there any new processes for shortening the time of annealing?

ANSWER

Malleable is at present made in air furnaces fired by hand with coal, with pulverized coal or with oil. It also is made in electric furnaces by duplexing or triplexing. In the duplex process the iron is melted in a cupola and poured into the electric furnace while in the triplex process the metal is melted in a cupola, then blown in a converter and then placed in an electric furnace for final refining. The resulting casting from any of these processes are annealed in muffle furnaces, intermittent pot furnaces in pits or above the ground, or in continuous kilns. Most of these types are fuel-fired. In a few cases electrically heated, elevator type furnaces using cars are employed for annealing. The castings are placed on the cars with or without support as the case may be, and elevated into the ovens.

The question of the best method is too complicated to permit a single answer for all methods are capable of producing a high quality product. The latest methods to be introduced are electric melting and electric annealing.

Aside from the proper control of chemical composition and melting stock to make a readily annealable iron, there is a proprietary process for accelerating the annealing rate of any hard iron casting by quenching *before* annealing. The process as yet is not in practical operation. Two other processes, also proprietary, are claimed to reduce the annealing time considerably. One of these has been described in the Oct. 1, 1929 issue of THE FOUNDRY. These processes are not literally new processes, but mainly constitute a new design of equipment for practicing well known methods with the minimum expenditure of time, a result which was accomplished earlier to a comparable degree in furnaces of the continuous type.

Patents also are in existence covering the use of various more or less unusual elements for the purpose of accelerating annealing.

Problems in Nonferrous Founding

By Charles Vickers

Copper Castings Crack

We have experienced difficulty due to the cracking of some copper castings we are making. These are square rods about ⅞-inch cross section and around 26 inches long between the bends at each end. These bends are at a right angle to the length of the rod, one bend extends for about 9 inches outwards, and the other at the opposite end of the bar to about 3¼ inches, and at about one-third the length of the bar there is an extension jutting outward in the same direction as the bends. This gives us a casting shaped somewhat like the letter "F." The cracks occur on the inner arcs of the bends, also at the angles of the extension, and in the body of the main rod-like portion, often breaking it into two pieces. We deoxidize the copper with 0.5 per cent of a 10 per cent silicon copper. Where is the best place to gate these castings? We would also like to learn how to make a hardener for an alloy of lead, 65 per cent; antimony, 25 per cent; copper, 10 percent.

The question arises whether these copper castings are being made in dry sand molds according to the prevalent continental European practice or in green sand as in the United States and Great Britain. If dry sand is used, then a change to green sand will prevent the cracks, but if the green sand method is being used, other changes will have to be made.

In this case we would gate these castings on the end having the short bend, and the gate would be located at the point opposite the main body of the casting. We would incline the flask 2 inches, so the molten copper would flow down hill. Now it is necessary to ram a mold to a certain density to make a casting true to shape, but to have the mold crush easily as the copper solidifies and contacts we would punch out a row of one-inch holes in the sand of the drag about ¾-inch away from the inner part of the long bend and more holes on either side of the extension, and at the inner part of the short bend. These holes are punched with a piece of brass tubing before the patterns are drawn in the case of hand molding.

If the patterns are put on plates for machine molding, it will be necessary to place strips on the pattern plate that will make channels paralleling the right angle extensions of the pattern. These channels and the holes weaken the inner wall of the mold so that it will crush in as the metal contracts instead of offering a resistance that is beyond the strength of the metal. As an added precaution the inner angles can be *tied* by making provision for a thin flash of metal to bracket the angles. This can be done on a plate by gluing a piece of thin cardboard where the flashes are wanted in the corners. All of the above can be carried out without materially decreasing the production.

We can see no advantage in making a hardening alloy for the white metal given, simply melt the copper first in a crucible, then add the antimony and when all is dissolved follow with the lead to rapidly cool the admixture to the point where volatilization of the antimony will cease. Such a white metal will be sluggish and difficult to cast.

Q & A

Gives Aluminum Alloys

Will you kindly send us formulas for two or three alloys of aluminum of different strengths.

The No. 12 aluminum is largely used. It consists of 92 per cent aluminum and 8 per cent copper. The best way to make it is to first form an alloy of 50 per cent copper, 50 per cent aluminum, known as 50-50, then simply melt 16 pounds of this copper-aluminum alloy with 84 pounds of ingot aluminum. The alloy can also be bought in ingot form, all ready to melt and pour into castings. Its strength will be around 20,000 pounds per square inch, with 1 per cent elongation.

Another alloy used for many castings is 83.75 per cent aluminum; 13.5 per cent zinc and 2.75 per cent copper. This alloy will have about 24,000 pounds per square inch tensile, with 2 per cent elongation. A third alloy contains: Copper, 5 per cent; silicon, 3 per cent and the remainder aluminum. This is a good casting alloy, as it does not crack as readily as some of the other alloys. The silicon is added as a silicon-aluminum hardener.

Q & A

Metal Oxidizes

We have lately encountered difficulty in making sound bronze castings such as small bushings, and we are sending two samples to better illustrate the defects. The metal is melted in an oil-fired furnace and it is made of 50 pounds of copper, with the addition of scrap of the composition of 85 copper, 5 tin, 5 zinc and 5 lead.

We assume because of the deep red color of the castings after machining, that half scrap and half copper was used for the mixture. Therefore, the metal contains only 2.5 per cent zinc, 2.5 per cent lead and 2.5 per cent tin. This is too rich a mixture and if not carefully guarded against oxidation while being melted, it will produce spongy castings, like the samples.

We suggest that 50 per cent copper and 50 per cent of 85, three fives scrap be melted together as previously, and that additions of 1 per cent tin, 4 per cent zinc, 5.50 per cent lead and 1 ounce of phosphor-copper be made. The phosphor-copper should be added first, next the zinc, then the tin and lead.

Bring the heat up to 2250 degrees Fahr. by pyrometer and pour around 2150 degrees. If the melting is done in crucibles, and a heat of 200 pounds is reduced in one hour starting with a cold furnace, or in 35 minutes with a hot furnace, then put into the bottom of the crucible, on starting, about 4 ounces of calcined borax, and go ahead. If the melting takes over an hour with a hot furnace, in addition to the borax, add some common bottle glass, not to exceed a broken quart bottle. Be sure in adding the phosphor-copper to drop it into the metal, and not on top of the slag, and do not use the slag when melting rapidly in crucibles.

Wisconsin Meeting
Features Foundry Problems

CO-OPERATION, as it exists in industry today, was illustrated in a spendid manner at the fourth annual foundry conference held Feb. 4 to 6 at Madison, Wis., under the auspices of the college of mechanics and engineering, department of metallurgy, University of Wisconsin. Over 125 foundrymen from Wisconsin and surrounding states met at the university to exchange valuable information on foundry practice. As has been the practice at previous conferences at Madison, practically all of the meetings were in the form of round table discussions.

The meeting was opened Tuesday afternoon by Prof. McCaffery of the University of Wisconsin, who was in charge of the arrangements for the conference. Prof. McCaffery called attention to the *Survey of the Gray Iron Foundry Industry*, which recently has been completed by the department of commerce. A number of the charts included in the survey, were projected on the screen, and the interesting features of each discussed.

Information Is Necessary

D. G. Anderson, Western Electric Co., Chicago, then presented a talk on "What Is Happening in the Foundry." He pointed out that since the demand for castings originates with the designing engineer, it is necessary for the foundry industry to present information on castings to the engineer which is comparable to that supplied by manufacturers of structural steel and other engineering materials. He also discussed the need for greater co-operation between the designer and the foundryman and pointed out the absolute necessity for good pattern-shop practice. F. B. Foley, Midvale Co., Philadelphia, discussed carbon steels.

The round table discussion began Wednesday morning. Four sessions were held each day from 8 a.m. to 10 a.m., two from 10:30 a.m. to 12:30 p.m. and four from 2 p.m. to 4 p.m. Four sessions were held on cupola practice under the leadership of C. J. Scullin, C. J. Scullin Inc., St. Louis. A variety of topics featured the discussion of these sessions, including refractories, slag hole, tuyeres, fluxing, change in the melting zone, lining the cupola, charging, tapping, making the bottom, forehearth tapping, etc. The final session was devoted to a discussion of cupolas.

Two sessions on apprenticeship training were in charge of C. J. Freund, Falk Corp., Milwaukee. In the discussion of this subject, apprenticeship was defined as an organized program under contract, either expressed or implied, for trade training. The need for apprenticeship training as a means of filling the lower supervisory field, as well as the need for experienced molders formed the keynote of the discussions. The development of craft knowledge, carrying with it the ability to anticipate difficulties and to apply correct foundry practice, was considered an important characteristic resulting from apprentice training.

The first round table on foundry practice was in charge of E. M. Handley, Chain Belt Co., Milwaukee. Discussion at this meeting centered around methods of determining the proper pouring time and the size of choke. This is accomplished by a special formula, which through classification, is made applicable to the jobbing foundry with a variety of work. The second meeting on foundry practice was in charge of William Bradley, National Steel Foundries, Milwaukee. Methods of gating both steel and gray iron castings, oil sand core mixtures for castings up to 300 pounds and grinding problems received the most of the attention at this meeting.

Heat treatment of steel was discussed at two sessions under the leadership of F. Kubosch, Turner Heat Treating Co., Milwaukee, and J. R. Houston, Harnischfeger Corp., Milwaukee. Various types of equipment best suited to various classes of commercial heat treatment were discussed. The cold working of cast steel during machining was mentioned. A case was cited in which a hard spot developed in the casting, causing it to be scrapped. An investigation showed that the hard spot was caused by a dull tool.

Harry W. Dietert, U. S. Radiator Corp., Detroit, conducted two discussion groups on the various phases of sand conditioning. The proper analysis of sands for steel, gray iron, brass and aluminum foundries were considered at the first session. Information also was presented on dry strength, bonding clays, methods of testing bonding materials, methods of testing molds, etc.

In discussing foundry management, F. K. Vial, Griffin Wheel Co., Chicago, illustrated the methods of planning followed by his company. He exhibited a copy of the standard practice code developed by his company over a period of 35 years. The second session on foundry management was directed by Frank G. Steinebach, managing editor, THE FOUNDRY, Cleveland, and considered problems regarding the relation of management to personnel. Dr. Fritz Meyer conducted two sessions on high test cast iron at which some interesting discussion developed.

Discuss Steel Practice

A steel session, lead by B. Aamodt, Milwaukee Steel Foundry Co., Milwaukee, considered basic electric operation, general problems of charging, different classes of scrap, degree of oxidation in melting and methods of refining. The second steel session, under the leadership of J. C. Sweitzer, Sivyer Steel Casting Co., Milwaukee, discussed general operation of the basic electric furnace, costs of basic and acid processes, maintenance, etc.

W. J. MacNeill, Federal Malleable Co., West Allis, Wis., led one session on malleable iron founding, where discussion centered around melting with hand-fired coal, powdered coal, and pitch. Melting rates of 2 tons per hour on hand firing, 3 tons per hour on pulverized coal and 3 tons per hour on pitch were reported. The composition of the charge and the features of powdered coal firing also were developed. Annealing malleable castings was considered at length at the second malleable session under the direction of Dr. Anson Hayes, American Rolling Mills Co., Middletown, O. Mr. Hayes described three new electrical annealing furnaces which have been installed at the Erie Malleable Iron Co., Erie, Pa., and operate on an annealing cycle of 72 hours. These furnaces, it is claimed, have reduced annealing costs and increased the machinability and other properties.

The FOUNDRY Family Photograph Album

Upper Left

J. S. PARKER
Motor Patterns Co., Cleveland

Upper Right

H. R. HIRE
Hire Foundry Co., Peoria, Ill.

Lower Left

S. C. WASSON
National Malleable & Steel Castings Co., Indianapolis

Lower Right

W. R. THOMPSON
Warner R. Thompson Co., Detroit

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

HINTS FOR THE COREROOM

(*Continued from Data Sheet No.* 800)

Mixing instructions: Add rosin to the sand in the powdered form and mix thoroughly 3 to 4 minutes, add about 7 per cent tempering water and continue mixing 4 to 6 minutes longer in a mechanical mixer.

Baking conditions: The recommended baking temperature is 325 degrees Fahr. During baking the rosin is melted and flows around the grains of sand thus forming the bond. If the rosin is volatilized or burned the bond is destroyed and therefore it is necessary to keep oven temperature at or below 325 degrees Fahr.

Use: Rosin cores are rather soft and weak but because of this they are particularly good for certain castings which require a readily collapsible core to prevent shrinkage checks. Rosin cores are used frequently for steel and aluminum castings. Rosin imparts no green bond and where this is necessary the colloidal or paste binders are added. Rosin is an important constituent of most commercial core oils in varying amounts. It also is marketed in solution under a trade name in which any desired amount of rosin can be obtained up to about 60 per cent rosin. Rosin is practically moisture proof and it also can be used to advantage with sand containing some clay content.

Core mixtures:

Miscellaneous small cores

20 parts clean open silica sand.
1 part powdered rosin.

Cores for aluminum castings

3 parts fine clean silica sand.
1 part fine molding sand.
1 to 15 to 1 to 20 powdered rosin. Spray with molasses water.

Miscellaneous Core Room Hints

Baking

An overbaked core, if it can be handled, is less likely to blow or scab than an underbaked core, but it will cut.

Underbaked cores will draw moisture from the air and the mold and soften more readily than properly baked cores.

Baking time required for maximum strength of oil cores varies with the square of the section and varies inversely as the permeability of the sand (or cores); that is the more open the sand the less time it takes to bake the cores.

Long drying at relatively low temperatures gives better cores than fast drying at high temperatures. That is the reason why night bakes are generally the more satisfactory.

(*Continued on Data Sheet No.* 802)

HINTS FOR THE COREROOM

(*Continued from Data Sheet No.* 801)

Pyrometrically controlled ovens mean a saving in fuel cost, better cores, and more uniform results.

Core equipment

Aluminum core plates greatly increase the speed of drying as aluminum conducts heat about 3 times as fast as iron.

Pasted cores are sometimes fastened together by means of wire and bolts. Bolts must be imbedded and carefully covered up to prevent the metal coming in contact with them during pouring. A satisfactory way is to use melted lead instead of sand or paste. This method is quicker, prevents the bolts from loosening and will not blow.

Core tests

Transverse strength expressed in pounds per square inch is taken as a measure of the strength of dried or baked cores. The test bar is 1 inch square and 8 inches long and is tested by loading at the center of supports 6 inches apart. The loading should be increased evenly and uniformly at the rate of about 24 pounds per minute. See tentative standards A.F.A. 1928.

Tensile strength expressed in pounds per square inch is used as a measure of the strength of dried or baked cores. The same test bar and apparatus are used as is used in testing cement. See tentative standards A.F.A. 1928.

Green strength may be measured by forcing a cone of a 30 degree angle at the point into a green core hemispherical in shape and 5 inches in diameter. The green strength is the load required to force the cone into the green core till it breaks or cracks apart. The load is added gradually and uniformly. For a complete description see *Transactions*, A.F.A. 1926, p. 558 by H. L. Campbell.

Moisture in cores

The recommended amount of moisture to use in cereal binder mixes is four times the volume of the binder. This will give the maximum dry bond strength.

The dry bond strength of oil sand cores is reported to be little affected by whether the oil or water has been added first in mixing. Others have reported that where sand grains contain small cracks or fissures it is more effective to add moisture first.

Every sand, bond, and mix has an optimum moisture content to give the best results. Many are beginning to believe that the moisture is as important as the bond and sand. More attention should be given to the moisture content in the core mixes.

(*Continued on Data Sheet No.* 805)

Fundamentals of
FOUNDRY PRACTICE

Equipment Is Employed Extensively in the Preparation of Green and Dry Sand Facing and Loam for Molds

By Ivan Lamoureux

Interpreted in the Light of American Practice by Pat Dwyer

Part IV

IN THE dry method, the sand first is subjected to a preliminary drying. The need of obtaining large quantities of facing sand by a rapid method and at little cost, has led some foundrymen to condition sands by the wet method, or to use them in the crude state, just as they come from the sand-pit without any drying. It should be noted that the fat or highly bonded sand which is hard to mix with the old sand, cannot be prepared by this method, hence it is preferable to use semifat sand, but in large proportions.

Use Wet Method

This condition does not obtain in American foundries where all sands are prepared for use without any preliminary drying. The old sand is screened, passed through a magnetic separator and then put into the mill with suitable proportions of semi-strong sand. After a few minutes of kneading, the sand is taken out of the mill, and passed over to the cutter to condition it further.

Advantages of preparing sand by the wet method include: Saving in the installation of sand conditioning equipment, saving in labor, rapid production, elimination of dust detrimental to the health of men working in sand conditioning plant, and detrimental also to the porosity of the sand. Automatic sand conditioning plants treat sand by the wet method. A quantity of fat sand is placed in a cast-iron pan about 6½ feet in diameter, with an iron pipe extending down to the bottom of the pan. Steam from this pipe tempers the sand which is stirred from time to time with a piece of wood. When the whole mass is well mixed, the required amount of water is added. It then is sprinkled with the dry sand that has been screened previously. The whole mass then is mixed, rubbed and cut.

Wet and Dry Sand

ALTHOUGH several pieces of mechanical equipment have been shown in which the sand is crushed and screened while in a dry state, the total amount prepared in this manner is small. Most of the sand intended for the formation of green and dry sand molds is prepared in a moist condition, or with approximately the same amount of water it will contain when in the mold. In the majority of European foundries loam mixtures contain several ingredients. American foundrymen employ a natural loam which only requires the addition of water to render it fit for use. Coal dust mixed with the facing sand and a protective coating of plumbago sprayed or brushed over the face of the mold impart a clean smooth skin to the casting. Reference here is to gray iron and malleable iron castings. On account of its high carbon content coal dust is not suitable as an ingredient in facing for steel castings.

In recent years, burnt sand has been reclaimed to some extent by clay either in the dry state or soaked in water. However, the practice has not become universal. The cost of sand delivered in any given district, usually is the determining factor on how the sand in the shop is maintained in volume and condition.

The need of producing perfect castings while devoting all their time toward securing a high and profitable output, has led foundrymen to buy their blacking materials in the open market. Formerly, each foundryman ground his own mineral black (powdered coal or coke) or his vegetable black (charcoal) and his lampblack. With simple apparatus, they were able to obtain suitable material for their requirements, yet withal, they were wasting time. Large firms now make a specialty of manufacturing foundry blacking and are equipped to do the sifting and bolting by machinery. The quality usually conforms with the price paid.

Prepare Blacking

Ordinarily the blacking mixture is stirred in a common tub or cask by any sort of stick. After a day or two, the heavy substances, the clay and graphite settle to the bottom while the light charcoal rises to the surface. The molder who does not take the trouble to mix it adequately before drawing, takes out a product which does not contain the various ingredients in the right proportions. Instead of an ordinary tub it is preferable to use the mixing bowl shown in Fig. 40, a cylindrical tank in which a shaft with paddles driven by a pinion and gear rotates constantly. The necessary quantity of black liquid required by each molder is drawn through a tap located at the lower end of the tank. The mixing-tank furnishes a well mixed product, and always is ready. It does not require any great amount of power.

The loam molder generally uses two kinds of sand: Backing or filling sand, and finishing sand. The composition of these sands varies with the type of mold to be obtained. Further on, the composition of some special mixtures will be presented. The backing or filling loam should be much harder than the finishing sand, to make solid molds. It is composed mostly of broken cores, old loam bricks, the residue after cleaning loam molding sands. straw, hay, tan bark and a small quantity of quite fat new sand.

Mills with rotary pans may be used to advantage for crushing and mixing the various ingredients. Mortar mills

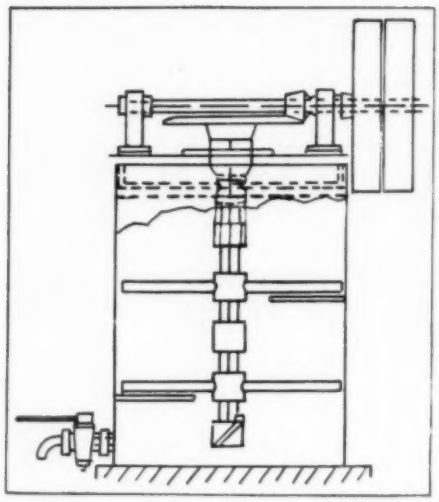


FIG. 40—MIXER IN WHICH BLACKING IS KEPT IN AGITATION

with heavy rollers, are not suitable for crushing the backing or filling sand, except for milling dry sand. The spherical cage rubbers may be used, provided however, that the perforated cages are replaced by smooth and hollow rollers and that the machine is cleaned thoroughly after each operation.

The finishing sand is much softer than the other, for the following four reasons: It is more porous, to facilitate escape of the gases released upon pouring. It is more easily finished, dressed and shaped to exact size. It prevents cracks and flaws at the time of drying. These mold defects increase the labor cost. It facilitates the removal of the cores after the casting is poured.

Gives Loam Composition

The finishing loam is composed of floor sand, of new weak sand, of horse manure and of bark, turf or peat. To mix all this material, small foundries usually employ mills with rotary pans. The vertical mixer is favored in the large foundries.

In every American foundry center where loam molding is practiced, a natural loam sand is available which only requires the addition of water to convert it into suitable material. It is prepared like mortar in a large, rectangular box and the only tools required are a hoe and a shovel. Used sand exclusively is converted into mud for laying the bricks. The first thickness of loam laid on the face of the brickwork may be made up of all new sand, or, a mixture of old and new sand in varying proportion. The finishing coat is made up of new sand that has been passed through a ¼-inch riddle. The *slip* coat, or final finishing coat is made of sand that has been mixed with water to the consistency of fairly thick claywash and then strained through a sieve with 8 meshes to the inch. This material is thrown over the face of the mold with a dipper and slicked into place with a single revolution of the sweep.

The vertical mixer, Fig. 41, consists of a cylindrical tank *A*, from 24 to 31 inches in diameter and from 39 to 46 inches in height. A vertical shaft of square cross-section *B* rotates in the center. The lower end of this shaft rests in a pivot *C* centered in the bottom of the tank, while the upper end is supported by the bracket *D*, attached to the top of the tank. The cast-iron paddles *E*, are attached to the shaft by clamps, while the other stationary paddles *F* are riveted to the inside of the tank. A horizontal drive shaft *G*, meshes with the vertical shaft *B*, through a bevel gear and pinion.

The substances to be mixed, sand, manure, etc., are put into the tank with the required amount of water. While the rotating paddles are mixing the sand and turning it over and over in every direction, the stationary paddles supplement the mixing by counteracting the gyratory movement to which the whole mass is subjected.

When the whole mass has been thoroughly mixed, the slide closing the opening in the bottom of the tank is raised and the sand is removed. The vertical mixer requires little power, occupies little space and gives good results. The screw type mixers similar to the one shown in Fig. 28, are well adapted for mixing loam, but the same does not apply to the mills with stationary pans, in which the rollers would throw the material out of the bowls.

Floor sand is the floor or old sand constituting the floor of the foundry where large or medium size molds are made. It serves for filling the flask. For sweep molding, additions to the floor sand are limited either to small quantities of new fat sand, dried and milled, or, some semifat natural sand. If the precaution is taken to eliminate all residue left over from the screening, the sand will be sufficiently clean and prevent some of the troubles encountered in molding practice. Treating floor sand by a mechanical screen, either electrically or pneumatically driven is desirable.

Molding in green sand or green molding, consists in making the impression in moist sand, which receives directly the melted metal. The origin of the word *green* is not definitely determined; it is assumed that *green sand* is used in the same sense as *green wood*, that is, not dried.

It might be assumed that the sands first employed were green as those from Cousance (France) and from Carnieres (Belgium). In fact, yellow sand to which coal dust has been added has a green tinge. This appears to be the real origin of the term *green sand molding*. Green sand molding is used in connection with all metals, steel, cast iron, copper and alloys, although many sands are far from suitable while in the green state.

Although small and average size iron and steel castings may be molded in green sand with perfect success, some difficulties are encountered in molding brass or bronze.

American sands from the state of New York permit green molding of wonderful castings up to several tons. These sands also give excellent results in Europe on brass and bronze castings.

Eliminates Fins

This sand is cheap as it does away with the need of drying the molds, gives clear and clean impressions, eliminates fins or burrs and accidents due to collapsing of the cores and core prints. The molds can be poured immediately after they are closed, thus effecting a saving in flasks and labor.

A suitable mixture of old and new sand for small green sand molds is made by putting the sand through the proper machines. The moisture should be sufficient to insure the proper plasticity or consistency, but not in sufficient volume to cause scabs or blowholes. As a rule up to 7 per cent water may be used.

If the castings are thicker than ⅜-inch, coal dust up to 5 per cent may be added to the facing sand, if over 1 inch thick, 10 per cent of coal-dust may be added. This amount never should be exceeded. No coal dust is used in steel molding sand. The carbon combines with the molten steel

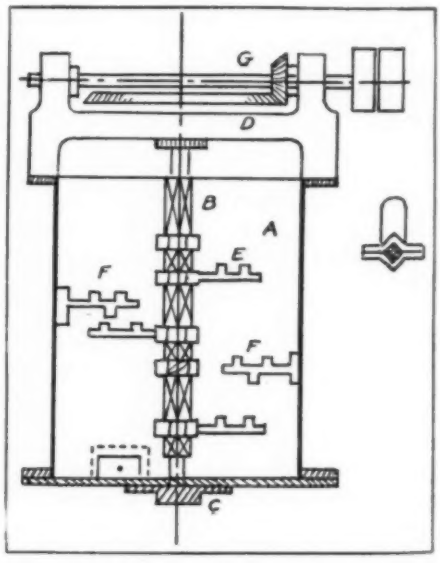


FIG. 41—VERTICAL MIXER FOR PREPARING SEMILIQUID LOAM

and makes it harder and more brittle.

In malleable iron castings this carburizing action interferes with the annealing process. Furthermore, for small castings the sand serves satisfactorily without coal dust addition. For bronze, brass and the white metals, high refractory qualities are not required of the sand. Thorough mixing and preparation of the old and new sand are sufficient.

What is the purpose of adding the coal dust? To reply to this question it is necessary to know just what reactions occur in the mold at the time of pouring. Some believe that the coal dust combining with the moisture from the water in the molds causes the formation of a gas which, in order to burn requires a large amount of heat it borrows from the iron and in that way renders the sand more resistant. It is sufficient for the foundryman's purpose to know that the cleaning or scouring action of the coal is a positive fact and that benefits are derived from its use in the molding of cast iron.

Dry Sand Molding

The main difference between dry sand and green sand is that green sand has to resist the pouring action in a damp condition while dry sand has to be resistant in a dry or baked state. Green sand should possess cohesion and plasticity and resist pouring in spite of the water it may contain. Sand for dry sand molds not only must be plastic in a wet state, but also be firm after drying so that it may be handled and will not be cut by the molten metal. If a green sand mold is dried, it crumbles at the slightest touch, and if it is poured, the risk is run of scabs forming on the casting. Likewise, if a dry sand mold is poured while green a rough casting and one full of defects will result. A too great hardness of a dry sand mold might be caused by an excess of clay in the new sand or perhaps to a too small proportion of old sand. This would produce cracks upon drying out which, in addition to spoiling the appearance of the mold, might cause parts to drop off.

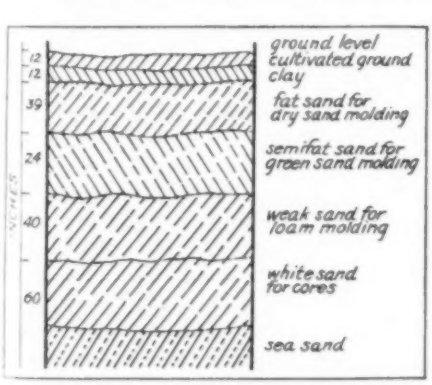


FIG. 42—TYPICAL FORMATION OF STRATA IN SAND DEPOSIT

Table III

Composition of Molding Sand Mixtures

Green Sand			Dry Sand			Loam		
No.	Sand	Per Cent	No.	Sand	Per Cent	No.	Sand	Per Cent
1	Old sand	50	1	Old sand	80	1	Old sand	50-65
	Weak new sand	45		Strong sand	20		Semifat sand	20-25
	Coal dust	5 to 10					Tan bark or turf	15-25
2	Old sand	90-95	2	Old sand	50-60		(Backing or building loam)	
	Coal dust	10 to 5		Semistrong sand	40-50	2	Old sand	20-50
3	Old sand	75	3	Old sand	70		Weak new sand	25-60
	Semifat sand	20		Strong sand	20		Manure or turf	20-25
	Coal dust	5		Peat, manure or tan bark	10		(Finishing loam)	

Dry sand of good coarse grains, semifat and well prepared, is suitable for steel. It should be well rammed. For cast iron the sand should be coarse-grained for the larger castings and of average size for the smaller ones. The ramming should be sufficiently hard to resist pouring, without being excessive, to permit escape of the gases. For nonferrous metals, sea-sand is employed successfully. This sand is found in the sand-pits just below the weak-sand bed as shown in Fig. 42. This sand is fine grained, permits obtaining nice appearing castings, but is not suitable except for dry sand molding.

When a thin casting with a large surface is cast in a mold prepared in dry sand, defects occasionally are found in the casting. This results from the fact that a too large release of gas has absorbed too large a quantity of heat and as a result has chilled the iron too quickly.

One of the reasons why molds are dried is to get rid of the moisture in the sand and thus reduce the amount of gaseous substance which has to be driven through the interstices of the sand when the surface is covered with molten metal and raised to a high temperature. Sand that is suitable for dry sand molding is of a coarser and more open grade than the sand employed in making green sand molds. This feature coupled with the absence of moisture after the sand has dried, obviates the necessity, to a great extent, of venting a dry sand mold. Vent wires have been discarded altogether in foundries where dry sand molding is practiced extensively. In many instances the example set on the dry sand floors, has induced the management to introduce a coarser, or more permeable grade of sand on the green sand floors where the vent wire also has been discarded. In a general way and under conditions where the sand is not all that it should be, it may be stated that green sand molds require the most artificial venting. Skindried molds require less and dry sand molds require least of all.

When flat castings are to be poured in open molds, that is, without a cope, the sand requires scarcely any plasticity. One therefore can make use of a sand containing little or no clay, such as old burnt sand. This essentially siliceous sand and other sand not containing coal-dust, give perfectly clean castings, but only in open molding. It is impossible to use this sand with any advantage in molding flasks.

Form Insulating Layer

Graphite or plumbago with a variety of secret and patented preparations, are brushed or sprayed over the inside walls of the molds for the purpose of forming an insulating layer between the sand and the metal. For steel and malleable iron it meets with the same objection as coal-dust on account of its large carbon content. Graphite may be sprinkled over molds in the iron foundry from a bag made of coarse cloth. However, only the horizontal surfaces receive an adequate amount of graphite in this manner. If the shape of the mold permits, all the surfaces should be coated by a brush. Although this latter method requires time, it saves considerable labor in cleaning the casting. The use of graphite does not eliminate the necessity for adding powdered coal to the molding sand.

Foundry terms for different kinds of sands and blacking include: Fat sand, strong sand, aluminous sand, loam sand, semifat or semistrong sand, weak sand or masons' sand, white sand, sea sand, silica sand, powdered coal, powdered anthracite coal, powdered coke, pulverized charcoal, liquid lampblack, primer, plumbago, Spanish lead, dust.

In making up the sand mixtures shown in Table III it is assumed that the sands have been given careful treatment. If the sand is improperly mixed, it may result in using double the amount of new sand. The figures given may vary somewhat, depending on the composition of the new sand, and also of the old sand.

Bill Thinks of Going on the War Path

By Pat Dwyer

SUPPOSE" said Bill, "you were talking confidentially to a lad on a subject of some moment and in the middle of the conversation, a total stranger pushed his way in. Suppose your man dropped you like a hot potato and devoted all his attention to this stranger, what would you do, hey?"

"Well," I admitted cautiously, "my action, or as the advertising boys say, my reaction would depend to some extent on circumstances. For example, I would give due weight to such factors as the height, reach, general physical condition and probable hitting ability of the party of the second part. If you had asked me what my impulse would be, I could answer you unhesitatingly. My impulse would be to hit him none too gently on the end of his nose."

"Just so," said Bill. "A good belt on the puss. I am glad to see that at least you are partly human. The good old spirit is willing, even if it is not strong enough to translate thought into action."

"My opinion on the subject," I hastened to add, "is purely academic. Off hand I cannot recall any incident of such a discourteous character as you mention. If I have been tempted I have forgotten it."

"Your recalling machinery," Bill remarked shortly, "is sadly out of kilter. It needs to be overhauled and oiled. It is covered with rust and verdigris. The gear teeth are rusted together and the shafts are jammed in the bearings. If you could summon up sufficient energy to get the creaking old mass in motion, you would remember hundreds of incidents where you were made the goat and left holding the bag."

"That is a new illustration," I said, "a goat holding a bag. It is on a par with Boyle O'Roach's classic: 'I smell a rat. I can see it floating in the air, but nevertheless, gentlemen, I propose to nip it in the bud!'

"I hear what you say, and in a general way I think I take your meaning, but with all due respect, allow me to submit that you are slightly in error, or even perhaps more so. The once bright intellect may be growing dim and the mellowing influence of the years may lead me to forget trivial slights and affronts of the past, but on general principles I object to your goat-and-bag comparison. I might tolerate one or the other singly, but the two together is just one too many. 'Sdeath! Gadzooks! Odds Bodkins and—er—what have you. In the good old days, men have been summoned to the field of honor for less."

"Keep your hair on," Bill interposed. "These are not the good old days when every trifling argument was settled by the ferocious expedient of slipping a sword between an opponent's ribs. If I was minded and if I had the time, I could remind you of instances where you got all steamed up over real or fancied slights. Instead of rendering you that little service, I'll tell you of an incident which happened today in which I was cast in the role of the goat. The same thing is happening to other honest yeomen every day over this broad land and I think it is about time a vigorous protest was entered. Will you join me in organizing an association for this purpose? We can call it *The Free and Independent Association of Billy Goats of North America* and adopt as our slogan: 'Butt in at your peril!'"

"Far be it from me," I said, "to interfere with the progress of any worthy cause. I have not the slightest conception of the aims and objects of the proposed association. At the moment I can see no necessity of adding another association to the millions already in existence. However, the title suggests fascinating possibilities in the way of regalia, initiation ceremonies and privileges usually accruing to charter members. The happy slogan should prove an irresistible appeal to millions. Now that the copyright on the Bock beer sign, once widely displayed as a harbinger of spring and happy days, has lapsed through default, I suggest that we adopt it for a heraldic device on our stationery and regalia. The funds of the order could be enhanced to a material extent by incorporating the same device, a goat rampant, on watch charms, stick pins, finger rings and buttons to be worn prominently in the right or left-hand lapel of the coat, depending on whether the candidate is a right or left-hander."

"I might have known it," Bill complained bitterly. "If there is any way of gumming the works, of making a monkey out of a proposition, of spoiling any legitimate enterprise, you are the bright little boy to discover it.

"The primary object of organizing the *Free and Independent Association of Billy Goats of North Amer-*

A FEW MORE POUNDS PRESSURE AND HE'LL POP!

ica is to right a crying evil. To offer an earnest and dignified protest to a situation that rapidly is becoming unbearable in a free country where every man presumably has equal rights. Piffly details of stationery, heraldic devices, regalia, right and left-hand buttons will adjust themselves automatically. They may be left to the discretion of the third assistant secretary. We, as the leaders and organizers of this great association, must devote ourselves to constructive effort. We must develop a smashing and effective method to back up our slogan: 'Butt in at your peril!'"

"Why all the sudden enthusiasm?" I inquired. "The great indoor game of butting in has been practiced ever since man discovered that he was equipped with the invincible combination of impudence, ignorance, a long tongue and two flat feet. Adam found that out in the garden of Eden when he interrupted the little seance between Eve and the Serpent, and you know what happened to him. If he had not butted in he would not have lost his job. What is more to the point, he would not have been responsible for the fact that all his descendants have been forced to scramble for jobs ever since.

"I have no desire to throw a bucket of cold water over your plan. I am heartily in accord with the spirit of the thing, but I am afraid the task is hopeless. Why not devote your time and talents to—I will not say a more worthy—but to a cause in which the chances of success are more apparent? Why this sudden and ferocious desire to smite the buttinski hip and thigh and then throw the battered remnants in the garbage can?"

"Well," said Bill, "I'll tell you. You jump to conclusions too hastily. The idea did not come to me suddenly. I have brooded over this injustice, off and on for a period of many years. The last straw was piled on the old camel's back today. Like the patient old ship of the desert, I have endured the rising load of injustice with only an occasional feeble wail of protest.

"The limit of endurance was reached today. In future—even if I have to do it alone—I intend to lift my voice in loud and violent protest. Yea verily, I shall be as the charger who snuffeth the battle from afar off and saith, 'Hah! Hah!' With bridle chains jingling and in full panoply of warlike array I shall just naturally jump on the next bird who pulls that trick on me, and that will be just too bad for him.

"Today, while in the vicinity of the city ticket office I decided to drop in and ask one of the bright young lads in the information coop for some dope on a trip I am contemplating to a town which involves a change of trains about half way. Whenever possible I prefer to travel by night, but as the total running time to this particular town is only about 8 hours, I was doubtful if I could make satisfactory connections.

"Several people were lined up at the counter. I made no attempt to butt in because I am a firm believer in equal rights for all and special privileges for none. I calmly awaited my turn and then told the young man what I wanted. I guess he is only an apprentice. He had to look the information up in a couple of time tables.

THE CANDIDATE TAKES THE GRAND BUMPER DEGREE

"A duly qualified informationist could have answered off hand: 'The *A B & C* out of here at 8:10 arrives in the first town at midnight. That will give you ample to ride across to the depot of the *X Y & Q* and catch a sleeper which leaves at 1:00 a. m., for the second town. This train arrives in the second town at 4:46, but your sleeper is kicked off there and you can stay in it until 7:00 a. m.'"

"If you knew all that," I naturally inquired, "why did you go to all the bother of calling at the ticket office?"

"Because," Bill explained patiently, "I am not a mind reader, a fortune teller or clairvoyant. I did not have all that information when I started out on the weary quest. Forty-five minutes of my precious time were spent in securing it and that is why—"

"Forty-five minutes! Do you mean to tell me you are so dumb that you required forty-five minutes to absorb a simple message like that?"

"Listen!" Bill cried in exasperation. "Lay off that silly stuff. I lost almost a precious hour today on account of people butting in. If I hear another squeak out of you I'll bar you from membership in the *F. & I. A.* of *B. G.* of *N. A.* In fact, I'll see to it that your name is placed on the black list and that means that every Billy Goat in good standing, with dues fully paid up, will be allowed the privilege and pleasure of bumping you every chance he gets. As you were! 'shun!

"This downy young gosling I was telling you about, started to paw through one of his time tables, but before he found anything, a woman behind me asked him what was the fare to Slippery Rock. If I had been in his place I would tell her to wait a minute until I had finished the job in hand. Did he do that little thing? NO! He dropped my book and spent five minutes hunting up this obscure little jumping off place and then mentioned the fare. She registered extreme indignation. 'The idea!' she said, '$3.91! I guess I'll take a bus.'

"The lad came back to me. 'L'es see,' said he. 'Where was it you said you were going?' I had a good mind to tell him that I was going to take a bus, but I reflected I might just as well finish the job since I had started. I repeated my story and he began again on the hunting expedition. Then his telephone rang and he dropped me. Judging from what I heard of the one-sided conversation, this client was going to Florida with various side trips on the way. She wanted full information on train schedules, junction points, dining car and Pullman accommodations, the state of the weather, high and low tides, points of interest along the way, and what kind of accommodations she might expect for her pet dog. For 20 minutes by the clock I had to stand there shuffling my feet like a lost dog while the fount of information feverishly thumbed through every time table he had in the place.

"At one stage of the game he had to acknowledge himself beaten. He appealed to his colleague who was busy at another point in the information booth. The colleague dropped his customer immediately and came to my lad's assistance. The call of the wild, I suppose, or something like that, cannot be disregarded. In fact, these birds seemed to be ready and anxious to answer any kind of a call—except mine and those of others in the immediate vicinity.

"When and if, I organize the Free

and so forth Billy Goats, I know where I can pick up the first dozen charter members. Also I know where I can discover the first dozen victims. We may not be able to cure them during the first session. The malady is deep-rooted and of long standing, but we at least shall have the pleasure of administering first aid, and how!

"Believe it or not, that accommodating young information clerk answered four additional telephone calls, each of approximately five minutes' duration, before he finally attended to me. At the fourth call I decided to enter a mild protest.

"'Say, young feller,' I said, 'just for a change, keep your paws and your elongated, hairy left ear off that telephone for a couple of minutes. Do you think I have nothing to do but stick around here all day? Tell that gink on the other end of the line to take a long running jump in the lake. Tell him you are busy. Tell him to call again. Tell him he has the wrong number. Tell him there is a wild man here waiting to jump over the counter. Tell him anything, or tell him nothing. Stick that perishin' thing back on the hook. Tell me what I want to know—while you are still all in one piece—and let me get out of here.'

"This courteous and straightforward request affected him profoundly. Yeah, just about as profoundly as my reading of the Declaration of Independence would affect a knock-kneed Missouri mule. Humped over the mouthpiece of the telephone instrument, he threw me a cold and fishy look. Also, after the manner of throwing a bone to a dog he informed me shortly that telephone calls *always* take precedence!

"If I were sure," Bill concluded darkly, "that the request would give that bird insomnia, St. Vitus dance and the pip, I would sit down some day, get him on the other end of the wire and ask him to work me out a schedule for a trip from Hudson Bay to Patagonia and from Apahauky to San Diego with a two-day stopoff at Slippery Rock and a week at Ecum Secum and Tatamagouche."

"I think you are too severe on the young lad," I pointed out to Bill. "He probably had no discretion in the matter. The old shipping code, 'Obey orders even though you break owners' probably also is in force on railroads."

"Well," Bill replied with a grin, "I don't suppose my occasional patronage will make or break this particular railroad, but I can tell you one thing, young feller-me-lad, I'll never ride on it again if I can find a competitive line that will serve me. Orders may be orders, but this young order taker was altogether too anxious to take orders. If he had said, 'Excuse me,' or 'Pardon me for a moment,' or 'I am sorry to leave you, but I have strict orders to answer the telephone promptly,' I might have fretted at the delay, but I would not have conceived a sudden and violent dislike for the clerk or the road he served. Instead of doing any of these things, his ears constantly were strained backward, listening for the telephone bell.

THE STRANGER IS SURE OF A HEARTY WELCOME

Even in the few brief intervals he talked to me his hands were on a tension, waiting to grip the instrument. He is a victim of the modern disease, telephonitis.

"Some people suffer more from this disease than others, but practically every person is afflicted to some extent. The sight of a telephone affects them as powerfully as a red rag in front of a bull. They can no more pass a telephone booth, than the old-time down and outer could pass a pair of swinging half doors. If one of these addicts enters an office he cannot possibly settle down to business until after he at least has made one call. Like any dope addict his hands, ears and mouth twitch until he has grabbed the instrument and delivered himself of the burning message: 'Say Ed, this is Joe talkin'. How's the boy?'

"The fact that Ed may be extremely busy at the time never enters Joe's mind. He banks on the knowledge that the telephone bell will draw Ed out of his hiding place as irresistibly as the gong in a fire station will bring the firemen sliding down the pole.

"I have never been able to figure out satisfactorily the reason for this obsession. You can call at almost any office in person and if the man you want to see is busy, he has not the slightest compunction in making you wait any time from five minutes to an hour. He does not ask if your business is insistent. He simply sends out word that he is busy and will see you as soon as he is ready. You can like it or lump it. He should worry. He sends out the word he can't see you and there you are. The fact that you may have come a long way, that your time may be valuable, that your call may benefit him materially, all these factors calmly are ignored. He is busy and can't see you. The particularly aggravating feature is that the operator who gives you the message also usually manages to convey the impression that you are a worm, and that you certainly have a nerve to even think of interrupting the great man. 'Take a seat,' she will observe, languidly admiring herself in succession from three angles in her little mirror. 'He says he may be able to give you a few minutes lataw!' Finally you enter the sanctum in blissful anticipation of an uninterrupted interview. You imagine if this bird is so hard to see, he also must be deaf to outside interruptions. Before the interview is fairly under way the telephone bell rings and you are left flat while some fat plug sitting comfortably in an office 20 miles away gets the undivided attention of your host.

"It's a tough racket," Bill concluded; "but then," perking up a little, "it has its lighter side. I heard a story the other day of a man who was invited to a stag party one night. To establish a good air tight alibi and thus avoid any awkward explanation later, he called up his wife and told her that urgent business would keep him at the office until quite late. He was left hanging in the air by his wife's reply. 'Can I depend on that?' says she!"

Members of the Pittsburgh Foundrymen's association heard a discussion on "Castings," by Dr. J. S. Unger, manager, central research bureau, Carnegie Steel Co. at the association's regular monthly meeting Jan. 20. About 75 members attended. Three reels of moving pictures entitled, "The Story of Steel" were shown following the talk.

Comments on *Production of* Electric Steel for Casting

By R. A. Bull

FOUNDRY conditions require that steel as tapped from the furnace shall be as nearly perfect as possible, and degasified to the greatest possible degree consistent with excellent physical properties. Gas cavities in an ingot are changed radically in form and rendered unobservable to large extent, by forging and rolling operations. Gas and other cavities in a casting constitute permanent defects, whose physical characteristics are unchangeable. Thus, the necessities of manufacture require maximum care and skill to be exercised by the foundry steelmaker.

Melters Favor Boil

Most experienced open hearth and electric steel melters will endorse Mr. Batty's opinion of the advisability of having a boil in the bath, induced by the introduction of iron oxide in some form. Indeed, there are numerous open hearth and electric melters who are addicted unwisely to the habit of providing for an excessive boil, in the writer's opinion. His observations lead him to believe that excellent and possibly the best results are obtained from a gentle boil. One reason for this lies in the fact that the regular practice of providing for a vigorous boil as compared with a gentle boil automatically leads the average melter, occasionally, if not frequently, to introduce some iron ore at too late a period in the working of the heat.

Admittedly it would be exceedingly difficult in the case of any particular furnace and customary heat charge to determine exactly the average time required for the oxides to be satisfactorily worked out of the heat, so as to leave the metal and the slag in suitable condition preparatory to tapping. We may advantageously discuss the matter in connection with a heat of customary size.

Most acid electric furnaces used for making steel for castings are of three tons rated capacity, and probably the majority of them customarily receive cold charges around 7000 pounds, or at least a charge somewhat in excess of the normal capacity as designated by the furnace designer. It is the writer's personal opinion that there should be no introduction of iron ore into an acid electric steel heat of the size mentioned, later than 45 minutes before tapping time. This opinion is advanced without the opportunity of definitely determining what period of time ordinarily is required to eliminate from the bath of metal the removable oxides introduced with the ore. Observation of conditions in the steel poured into casting molds presents the only justification for the recommendation.

The writer feels free to express the opinion he now holds, reserving the right subsequently to modify his views in this as in other details, according to evidence that may be accumulated. It at least will be admitted that in all such cases as the one involving the addition of ore, it is advisable to be on the safe side. Unquestionably it is bad practice to tap an electric steel heat from which the oxides have not been eliminated within reasonable degree. Time is an important element in such elimination, and there are other factors, including the important one of suitable bath temperature. It is the writer's opinion that considerable improvement in electric steelmaking practice for castings will be effected when late iron ore additions become a thing of the past.

Gives Influences of Copper

Mr. Batty's references to the influence of copper are interesting. He advances the idea that cold shortness, which appears to him to be associated with a copper content in the steel, may be dependent to a considerable extent on the combined influence of that element and phosphorus. When the percentage of phosphorus is fairly high and when there is an appreciable proportion of copper in the metal, the writer believes the observable, important effect on the product would be redshortness, due to both copper and phosphorus; and coldshortness, due to phosphorus.

If copper is a contributory cause for coldshortness, the writer has not observed definite evidence of the fact. However, he believes that phosphorus is a contributory cause for redshortness, not by any means to the same degree that sulphur demonstrates its

Discusses Methods

IN THIS article the author discusses electric melting as related to ore additions, degasification, and the effect of copper, in the manufacture of steel for castings. He expresses the opinion that, while a substitute for aluminum as a degasifier should be the object of a determined search, the use of this material for the elimination of metal and mold gases may be curtailed beneficially by correcting the conditions that have made relatively large additions of aluminum necessary. This article is compiled from a written discussion of a paper entitled "Production of Electric Steel for Castings" by George Batty, abstracted in the Feb. 1 issue of THE FOUNDRY *and presented at the annual meeting of the American Society for Steel Treating held in Cleveland, Sept. 9-13. Major Bull, the author of the discussion, is director, Electric Steel Founders' Research group, Chicago.*

effects, but to some extent. That condition was indicated by conditions observed in the manufacture of certain steel castings, which by reason of their designs were susceptible to shrinkage cracks, and which called for the maximum precautionary measures in the manufacture of metal and mold.

It generally is conceded that copper in large quantities has a redshortening effect, the bad results of which are felt by the foundryman, and not often by his customer. At what minimum percentage this influence begins to be exerted probably is not known. The increasing difficulty of obtaining purchased scrap free from alloying elements outside the scope of what is termed common steel, points to the advisability of ascertaining what effects are produced in casting steel, not only by copper but by other elements which frequently exist in the scrap charge, and are present without being desired by the foundryman. The degree to which the use of alloy steels is being extended makes probable the utter impossibility, five years hence, of obtaining such material in a physical form most suitable for electric steel melting, and at the same time having a chemical composition justifying classification as common or carbon steel.

Discusses Porosity

The writer subscribes to Mr. Batty's opinion that porosity in steel castings is caused generally by mold rather than metal conditions, although there is no disputing the fact that pin holes may be produced by an undesirable condition of the metal. No one who is informed even partially on the subject would argue against Mr. Batty as to the injurious effects of aluminum on ductility. In saying this the writer does not take issue with those who have pointed out from time to time that an appreciable amount of aluminum added to a well prepared steel heat appears, in occasional instances, to cause no bad effects on the physical properties. Without doubt the phenomenon mentioned sometimes occurs, when conditions probably not fully understood by any metallurgist happen to be such as to keep out of the vital area of the test specimen, injurious compounds formed from aluminum and other elements.

It is the writer's belief that some persons have been deceived as to the influence of aluminum, by failing to consider the time factor. When this deoxidizer is added to the metal at the furnace spout during the tapping operation, and the metal subsequently is permitted to acquire and remain in a quiescent state, ultimately being poured into molds by withdrawal of the steel from the bottom of the original ladle used, there appears to be the minimum opportunity for harmful oxides to find their way into the castings. Time permits the lighter inclusions to rise toward the surface of the metal when there is no mechanical disturbance to interfere. For these reasons a moderate aluminum addition made to a ladle of steel at the furnace spout often may fail to result in apparent injury to the steel, if a sufficient period is allowed for the inclusions to levitate, and if pouring is done through a nozzle at the bottom of the ladle.

Eliminates Mold Gases

However, there is a disturbing circumstance in the demonstrated fact that the aluminum treated steel is effective in eliminating the mold gases, practically in proportion to the lateness of introducing this element. Extremely hot steel exposed to the atmosphere for a short interval before it enters a green sand mold is unquestionably in better condition to eliminate the mold gases when the aluminum is introduced into the ladle used to fill the mold just before the mold is poured, than when the aluminum is added at the furnace spout, when, in some plants, a larger or bull-ladle is employed.

The search for a satisfactory substitute for aluminum is warranted. It has been carried on by many steel foundrymen, but with a degree of success that to a large extent is indirect rather than direct. Most of those who have earnestly endeavored to find such a substitute probably have reached the conclusion that the best results of efforts to prevent pin holes in green sand steel castings and at the same time to employ judiciously a small proportion of aluminum, consist in measures to prevent the condition which aluminum corrects, namely, an excessively gaseous condition in the mold when it is being poured.

This is being accomplished to considerable extent by carefully determined and positively maintained control procedures, related not only to the all-important matter of moisture in the molds, but to the phenomenon of volatility as involving certain relatively dry materials in the mold; to venting practices by means of channels mechanically created to permit the exit of gases; to the permeability of the molding sand; to the suitable condition of ladles and all other equipment required for heat pouring; and in brief, to every one of a large number of details of foundry practice which may be contributory if not prime causes for the formation or retention of gas.

It would not solve the important commercial problem of manufacturing steel castings free from pin holes to proceed on the apparently simple hypothesis that castings that need to be perfectly sound should be made in oven-baked molds. Important commercial factors require that a great many steel castings be formed in green sand molds. Such molds represent one of the greatest safeguards obtainable to prevent troubles from redshortness, exhibiting themselves in shrinkage cracks or checks.

When we stop to think about it and consider that, increasing with the temperature of the metal, the shrinkage of steel as ordinarily poured in a foundry averages around ¼-inch per foot when the members of the casting are not such as to restrict the contraction, we have some appreciation of the strains that may be set up in certain castings in their plastic state immediately after the mold is filled, by reason of the positions and sizes of the members that obstruct the shrinkage. When the mold is of hard, unyielding nature characteristic of sand that is thoroughly baked, obviously its resistance is much greater than when it is not baked, but is substantially in the compressible condition it must be in when the molder rams it around the pattern. There are innumerable designs which could not be produced satisfactorily in the ordinary type of dry sand mold without danger to soundness due to cracks, or without such heavy percentages of losses as to make manufacture too costly to consider commercially.

Unify Foundry Costs

(*Concluded from Page* 83)

same normal overhead percentages are ordinarily used without change throughout the year, any necessary adjustment being made at the end of the year.

Cost of Individual Castings

The old method of quoting flat prices or a schedule of prices by weight usually works out to the disadvantage of the foundry. Many foundries are refusing to quote flat prices. It is strongly recommended that whenever possible foundries insist on quoting individual pattern prices per pound or per piece. In some cases average prices can be quoted on a machine, or class of machines, but if so, individual pattern costs should be figured on all castings required for the machine, and these costs averaged. Such average prices should only apply if the customer or-

ders the complete list of parts specified in his inquiry.

Profit

The astounding percentage of business failures clearly shows the necessity for establishing selling prices which not only cover the complete cost of doing business, but also include sufficient profit to enable the company to perpetuate itself and make new improvements. A company can be permanently successful only when the element of profit is given careful consideration before selling prices are established.

It is necessary when making quotations to include an amount of profit sufficient to insure returns which will be large enough to assist in payment of dividends during periods of business depression which occur from time to time.

It is also necessary when establishing selling prices, to include an amount of profit in addition to that required for dividends during periods of depressed business, sufficient to provide for a consistent development of the business and for the maintenance of surplus reserves. This is a fundamental economic principle upon which the permanent success of any industry must be based. This principle is often disregarded to the detriment of the entire industry.

This is the third and last of a series of articles presenting the standard cost system prepared by the cost committee of the Gray Iron Institute.

—THE EDITORS.

Brass scrap remelted in 1928 amounted to 302,000 short tons which is an increase of 5.6 per cent over that melted in 1927. Metallic aluminum during this same period showed an increase of 6.5 per cent or an increase from 23,200 short tons in 1927 to 24,500 short tons in 1928 according to a bureau of mines publication on secondary metals.

Three Men Charge 150 Tons Daily

THE foundry of the Vulcan Mold & Iron Co., Latrobe, Pa., is built on the side of a hill. Not much of a hill, it is true, but still sufficient to prove a decided economic factor, particularly in handling the raw material for the cupola. The charging platform is on the same level as the stock yard, therefore no elevator is required. The foundry was established on a modest scale in 1923 to handle an output of 25 to 50 tons of ingot molds and related castings per day. The building was extended from time to time to cope with increased production schedules. Machines, ovens and other time and labor saving pieces of equipment have been installed at various periods and the daily heat has risen from 25 to 150 tons.

Originally the cupola charge was loaded in barrows, wheeled to the charging door and thrown into the cupola by hand. As the heats became heavier the number of men and barrows was increased. Around the 100-ton mark seven men were needed on the charging floor. The prospect of still larger heats prompted the adoption of the present method shown in the accompanying illustrations where a lift truck and three men do all the work incident to handling heats up to 150 tons.

The plant is located on a spur from the Ligonier Valley railroad which in turn is connected to the main line of the Pennsylvania railroad running east from Pittsburgh. Pig iron, coke, scrap and limestone are brought in on the spur and are unloaded by a crane on a stockyard that is floored with iron plates. The iron for the charge is loaded into a special steel pan mounted on the front of the truck and is carried to the cupola. Here the pan is elevated approximately 3 feet and then tipped forward to spill the contents into the cupola. Four stiff steel legs support the loaded pan while in transit from the yard to the cupola and thus remove the strain from the tipping mechanism until the time comes to lift the pan and dump the contents into the cupola. The truck is operated by a storage battery which is charged at night.

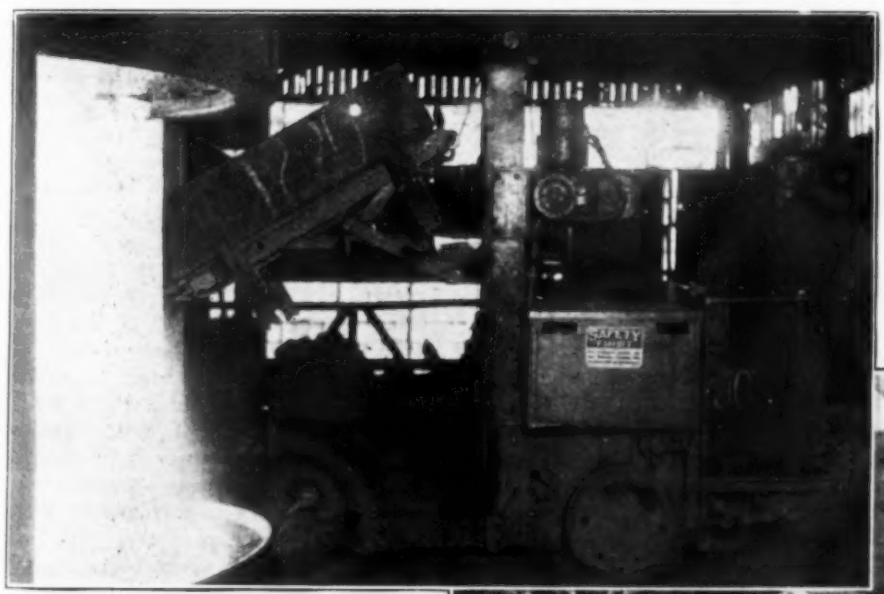


FIG. 1—(LEFT) THE PAN IS TIPPED AT A SUFFICIENT ANGLE TO DISCHARGE THE CONTENTS INTO THE CENTER OF THE CUPOLA. FIG. 2—(BELOW) FOUR STOUT STEEL LEGS SUPPLEMENT THE TIPPING MECHANISM IN SUPPORTING THE PAN

Readers Comment

Note—Material appearing under this head does not necessarily reflect the opinion of THE FOUNDRY or of its editors.

TO THE EDITORS:

With reference to the discussion on the Belgian exchange paper which was presented at the French foundry convention held in Paris and reported in the Jan. 1 issue of THE FOUNDRY, the Association Technique de Fonderie de Belgique wishes to point out that the Belgian paper related to the subject of shear testing. Its main object was to set forth the adjustment of the shearing test from the standpoint of obtaining a test piece having the correct diameter and of eliminating parasitic bending influences which distorted the shear effect as determined by the first machines used.

Results obtained were compared with tensile results because some comparison was necessary. Such comparison only could be made with current test results such as those obtained from the tensile test.

VINCENT DELPORT

London, England.

Metal Is at Fault

TO THE EDITORS:

Under the title "Mandrel Is Cool," on page 618 in the July 15 issue of THE FOUNDRY, a question was asked and answered on the cause of pin holes in babbitted bearings. While the answer given is partly right in that the mandrels should be hotter at the start, there should be no difficulty after a few bearings are lined. Rosin is not necessary and will not stop the pin holes. I believe that the trouble is from the original babbitt. Another point neglected is the pouring temperature. This is given as 700 to 750 degrees Fahr. According to my experience, the temperature should be around 850 degrees Fahr.

H. R. KING

Chicago

William J. Brant, Pittsburgh, secretary-treasurer, Pittsburgh Foundrymen's association, has been elected a director of the Industrial Silica Corp., Youngstown, O.

Ohio Foundrymen Meet at Dayton

MATERIAL handling in small foundries, advances in nonferrous practice and various items connected with the Ohio foundry code occupied the attention of members of the Ohio Foundries Association Inc., at a well attended meeting in the Miami hotel, Dayton, O., Feb. 5.

Tony Kramer, Advance Foundry Co., and vice president of the association submitted a report of his activities in Columbus in connection with the preparation of a code to govern the conduct and operation of the foundries of the state. Representatives of labor, the industrial commission of Ohio and the Ohio Foundries Association, Inc., held joint meetings to agree on this code.

From the employers standpoint some of the advocated measures are entirely unnecessary and if adopted are bound to inflict an unjust financial burden on foundry owners. A strict interpretation of many of the proposed clauses will interfere with the efficient operation of a foundry. For example one proposed measure would have a craneman lift any chains or loads at least 10 feet from the floor before he moved his bridge or rack. The absurdity of this was pointed out by Mr. Kramer in the case of lifting a large cope. After the crane chains are attached the molder may find it necessary to move the crane hook a few inches north, south, east or west to bring it more truly over the center. In strict compliance with the foregoing clause in the code he must disengage his chains, allow the crane man to hoist them 10 feet, then move his bridge or rack the required distance and then lower the chains again.

Mr. Kramer advocated a stricter observance of all safety measures and stressed the necessity of a thorough physical examination of all applicants for employment.

W. B. Marshall, the Chain Belt Co., Milwaukee cited several instances in support of his claim that various forms of mechanical equipment are coming to be recognized as an actual necessity in the modern foundry. Large foundries discovered this fact long ago and were the pioneers in the movement to have the great bulk of their work done by machinery. On account of the economic features involved, many of the smaller foundries have found and are finding it advisable and profitable to follow the example.

He claimed it is impossible to set down any hard and fast rule on the best type of equipment to adopt. Local conditions govern this feature. In a detailed analysis of operating costs in a foundry producing 25 tons of small and medium weight gray iron castings he showed that installation of mechanical equipment showed a saving of $61,000 on an investment of $40,000 for equipment. Under ordinary conditions a small foundry operating as small a number as 10 molders can install equipment for handling practically all the material used and pay for it easily in 2 years. In one typical case the cost of handling all the material going into the cupola has been reduced to 12 cents per ton. In another a moving belt proved a highly improved factor in carrying the castings from the shakeout, past the various cleaning devices into the shipping room in segregated lots. Touching on the sand handling feature, the speaker claimed that on account of the number of times it is handled, the weight of sand equals 16 times the weight of the iron poured in a foundry. A snap flask molder putting down 200 molds on a floor 10 x 25 feet carries this sand 1 mile.

A. A. Grubb, metallurgical engineer, Columbus, described many of the advances that have characterized brass foundry practice in recent years. As a result of investigation from a theoretical and practical viewpoint, the ingot metal now supplied is of a higher character than formerly. In lauding the work of the sand research committee of the American Foundrymen's association he claimed one of the most important features is that it has given foundrymen a language of understandable terms. An interesting elaboration on furnaces and melting practice centered around the importance of a correct pouring temperature. He particularly warned against the danger of over heating the metal in the furnace and then cooling it to pouring temperature. On two test bars poured at the same temperature but melted at 2050 and 2300 degrees Fahr., the respective results showed: Yield point 12,000 and 8000 pounds per square inch; ultimate tensile strength 31,600 and 16,800 pounds per square inch; elongation 26 and 12 per cent; reduction in area 33 and 15 per cent; brinell numbers 56 and 32.

What Others Are Thinking

Abstracts Selected from the World's Foundry Literature

Explains Solidification Phenomena

High Duty Cast Iron, by J. E. Hurst, *Iron and Steel Industry*, London, September and October, 1929.

Solubility of gases in cast iron influences the solidity and physical properties according to the author. This is explained on the basis that at high temperature, solubility of gases in the metal is at the maximum. As the temperature decreases on casting and the metal in the mold solidifies, the solubility decreases and the last portion to solidify will contain blowholes and unsoundness if any excess gases are present. In cylindrical molds the outside walls solidify first and the metal is drawn from the center. As the remaining metal becomes solid the gases are concentrated at the center of the remaining portion of the liquid metal. If the concentration is high enough the gases must find their way through the length of the casting or be entrapped in the casting. Shrinkage also has a tendency to cause unsoundness but may be alleviated by the use of feeder heads.

Soundness in centrifugal castings, according to the author, is due to the fact that the high pressure gradient in this type work forces the gases from the casting. The close, fine grain is due to the rapid rotation of the mold. The main advantages of centrifugal castings are freedom from internal defects, soundness, closeness and uniformity of grain size and increased mechanical properties.

A variation of the centrifugal process known as the spun-sorbitic process enables castings to be produced by this method from low carbon, low silicon irons with maximum combined carbon and mechinability. When the casting is cooled, it is subjected to the action of a wet air blast suitably regulated, which produces a sorbitic structure. This structure is resistant to wear and the inside of the casting which is exposed to wear is so treated. Chemical composition of such castings is as follows: Total carbon, 3.00 per cent; graphite, 2.03 per cent; combined carbon, 0.97 per cent; silicon, 1.31 per cent; manganese, 0.42 per cent; sulphur, 0.11 per cent; phosphorus, 0.34 per cent. Tensile strength showed 64,700 and 59,100 pounds per square inch on two specimens.

Presents Data on Annealing

Neuzeitliches Gluehen von Grau-und Temperguss (Modern Annealing of Gray Iron and Malleable Cast Iron), by Rudolf Stotz, *Die Giesserei*, Dec. 27, 1929.

The author describes various types of heat resisting iron alloys for annealing pots and gives some comparative figures on the pot cost per ton of annealed castings. He also discusses packing materials and their preparation. Considerable space in the article is devoted to a description of different types of stationary and tunnel-type annealing ovens fired by powdered coal and gas. In the discussion of powdered coal firing he includes figures on the cost of installing a coal grinding plant. In conclusion the author presents some ideal annealing curves for white-heart malleable cast iron, black-heart malleable and gray cast iron. These curves give the temperatures and the holding period at these temperatures to obtain the best results with the material mentioned.

Discusses Foundry Mechanization

De la Manutention Mecanique en Fonderie, (Mechanical Transportation In the Foundry), by Vincent Delport. *Bulletin*, Association Technique de Fonderie, Paris, November, 1929.

This is a reprint of a paper presented before the French association in Paris, in which the author compares American methods with those used in Great Britain and on the Continent. In view of the large production obtained in the United States, American methods should not be copied by European foundries, but these methods may be adapted to European conditions to great advantage.

The use of machinery and mechanical appliances in America is necessary, because they speed up production, and reduce labor costs. In Great Britain, while wages are substantially higher than on the continent, there still is some resistance among a certain class of workers against the use of machines, because of the unemployment which prevails in that country. In France and Belgium labor is cheap comparatively, and for that reason machinery is not needed to the same extent as it is in America. Contrary to the conditions existing in Great Britain, France suffers from a shortage of labor, and consequently the lack of workers should be made up by the use of machines and mechanical methods.

The general principles applied in the use of mechanical methods in America are given and illustrated by the description of American foundries having a production of not more than 50 tons per day. This rate of production was chosen because it rarely is exceeded in European foundries. There also is a description of the foundries of the Midland Motor Cylinder Co., Ltd., at Coventry and Birmingham, England, and of a part of the foundry of the Stanton Ironworks Co., Ltd., near Nottingham. The foundry of the Midland company specializes in the production of parts for motor-cars, both in cast iron and aluminum. The Stanton company is a large producer of cast iron pipe, and does some production work. It is the particular branch of the works devoted to production work that is described.

Outlines Electric Furnace Practice

Steel Castings, by C. Howell Kain, *Foundry Trade Journal*, London, Dec. 5 and 12, 1929.

The author has made a study of the methods used to produce steel for casting in the basic electric furnace. He comments on the lack of *life* found in steels produced in electric furnaces of the basic type and explains that by proper control of the temperature and slag, by removing the slag while the bath was boiling gently, quickly building up the reducing slag and finishing as quickly as possible, the steel produced had *life* similar to bessemer steel and thin sections could be run easily.

He contends that the factors that influence the life of the steel are: To arrange to composition of the melt so that there is no free ferrous oxide while the steel is unprotected by a layer of slag and is being melted under high arc temperature; to control the ore additions so that there is little or no excess oxide present at the end of the oxidation period; to avoid a strongly reducing period which tends to reduce the life of the steel; and to work the heats as quickly as possible. Oxygen and calcium silicide are advanced as being the cause of lack of life in the steel.

In adding ferrosilicon to the bath, the author recommends that it not be added immediately after the removal of the oxidizing slag but to wait until the slag is white and generates acetylene on quenching. A higher yield of silicon is obtained in this manner of manipulation. This is shown in a chart. He admits that the deoxidizer added in the ladle may play a part in the final yield, for in steels where titanium was used the yield was higher than those in which aluminum was used. He also comments on the use of aluminum and titanium as deoxidizers and how to secure the greatest benefits from them.

In commenting on the fact that various parts of a casting may exhibit different properties, the author gives data to support the statement. He also explains the reasons for that difference.

Controls Cupola Air Pressure

Some Notes on the Air Supply to Cupolas, by R. T. Rolfe, *The Iron & Steel Industry*, London, December, 1929.

Many cupolas are equipped with apparatus to control the air pressure to the cupolas but some do not have volume indicators. In this article the author explains the construction and calibration of pressure gages for the cupola. He also gives many definitions for terms used. By following the directions given in the article it is possible to construct simple gages and to calibrate them. The author explains and shows how to calculate the amount of air which must be supplied to the cupola.

The Shakeout

DAN M. AVEY, *Editor*
FRANK G. STEINEBACH, *Managing Editor*
PAT DWYER, *Engineering Editor*
EDWIN BREMER, *Metallurgical Editor*
CHARLES VICKERS, *Nonferrous Editor*
NORMAN F. HINDLE, *Assistant Editor*

¶ Coals To Newcastle

IN A recent publication issued by the Nevada state bureau of mines, the statement appears that Belgian molding sand is imported into California. To the casual reader this is reminiscent of the old classic about carrying coals to Newcastle. Newcastle on the northeast coast of England is the great shipping port for much of coal hoisted in the north country. The paradox of shipping coal into this port is about on a par with shipping sand from a European country into the United States, with its natural resources of molding sand suitable for every requirement. While it is true that up to the present no sand has been discovered in California equal to the excellent sand produced in Belgium, that necessarily does not imply that equally excellent sand does not exist in the Pacific coast state.

FOR many years California foundrymen have imported a considerable volume of suitable sand from the East and the Middle West, but the heavy freight charges on such a long haul have imposed a severe handicap. The comparatively low ocean freights across the Atlantic and through the Panama canal account to some extent for the importation of Belgian sand on a competitive basis. California foundrymen might find it to their advantage, either independently or in connection with the state and federal geological department, to appoint a competent man to make an intelligent survey of the state with a view of locating suitable molding sand deposits. Proper revivifying, and rebonding and treatment will prolong the life of the shipped-in product. With the presence of local silica sand deposits, shipment of rebonding clay should prove profitable.

¶ Increase Plant Facilities

WITHOUT doubt the condition of the steel castings industry is on the upgrade. According to figures available from the department of commerce, the past year should be the highest since 1920 from the standpoint of bookings production and capacity. In 1923 the steel casting industry booked 1,163,589 net tons of castings which was the largest tonnage since 1920. Total bookings for the first 10 months in 1929 were 1,147,481 net tons, only 16,108 net tons less than in the total year 1923. In 1928 the capacity of operations for the first 10 months was 56 per cent compared with 79 per cent for 1929 in a similar period based on bookings. The output based on production capacity for 1928 was 59 per cent against 78 per cent for 1929 during the previously mentioned period.

THESE figures indicate a healthy condition in the steel foundry industry during the past year which may be expected to be carried over to the first quarter of this year. The steel foundry industry has a sufficient number of plants to take care of the present demand. However, steel foundrymen anticipating further increases in production might take this opportunity to reduce their costs and increase their plant capacity by supplanting obsolete equipment with modern production facilities.

¶ Watch Your Step

PRACTICALLY all reports from reliable sources in the foundry industry indicate an upward trend in business expected for the early spring. Accordingly jobbing interests should be on guard against indirect and direct propaganda subtly concocted to effect unwarranted reductions in prices. Much of this propaganda emanates from one industry which ever is prone to take advantage of the slightest indication which may be twisted into an interpretation showing the downward trend of prices. However, it recently appears that propaganda did not bring the desired results so the strong-arm method was put into effect in one case of a large buyer of castings.

A FEW of the foundrymen called together by this one member of the industry were favored with large orders at a price below the production costs. In a few days, other members of the same industry sent their casting requirements to other foundrymen, brazenly stipulating that they could have the business at the same price obtained by the favored few previously subjected to the reducing treatment. The foundryman's part in this story is to make a firm resolution—Never, under any condition, accept an order wherein a reasonable profit cannot be made. Accepting unprofitable orders just to keep the shop working may engender a serious repercussion.

Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

F. F. ELLIOT, formerly works manager, Cleveland plant, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been appointed director of foundries of the company, with headquarters at East Pittsburgh. Mr. Elliot was born Feb. 11, 1872, at Kent, O. He received his early education in the schools of that city and later became an apprentice patternmaker at the Bucyrus Steam Shovel & Bridge Co., Bucyrus, O. After he completed his apprenticeship, he worked

F. F. ELLIOT

at a number of shops including the plant of the Standard Sanitary Mfg. Co., Pittsburgh. In 1902, he entered the employ of the Westinghouse Electric & Mfg. Co., as a patternmaker at the Allegheny foundry, North Side, Pittsburgh. In 1907, he was promoted to pattern shop foreman. He was transferred to Cleveland in 1916 in the same capacity. In May of that year he again was transferred to East Pittsburgh and placed in charge of the brass foundry at that plant. The Westinghouse company erected a foundry at Springfield, Mass., in 1920 and Mr. Elliot was appointed foundry superintendent. He was transferred to Cleveland in 1924 as works manager which position he held until his recent promotion.

George O'Brien, formerly in charge of employment, Alliance, O., plant, American Steel Foundries, has been transferred to the wheel department. He is succeeded by C. B. Alexander.

A. H. Lauer, manager, Sharon, Pa., works, American Steel Foundries, has been transferred to the Granite City, Ill., plant. He is succeeded by Albert E. Moses. The Sharon works has been closed since 1922.

George L. Dumbauld, assistant treasurer, Blaw-Knox Co., Pittsburgh and Blawnox, Pa., has been elected treasurer. He succeeds Benjamin L. Hirshfield, who resigned recently to become chairman of the finance committee in succession to Maurice Falk.

Arthur C. Pletz has resigned as assistant sales manager of the Pratt & Whitney Co., Hartford, Conn., to become associated with the production department of Aluminum Industries Inc., Cincinnati.

A. W. Remensnyder, formerly assistant treasurer, Duquesne Steel Foundry Co., Pittsburgh, was elected treasurer at the recent meeting of the board of directors.

Herbert A. May, vice president, Union Drawn Steel Co., Beaver Falls, Pa., has been elected a director of the Pittsburgh Steel Foundry Corp., Pittsburgh with works at Glassport, Pa.

Theodore Ahrens has resigned as president of the American Radiator Co., New York, but will continue as president of the American Radiator & Standard Sanitary Corp. Rolland J. Hamilton, formerly vice president, succeeds Mr. Ahrens.

John F. Tinsley, vice president and general manager, Crompton & Knowles Loom Works, Worcester, Mass., has been selected as one of the New England representatives who will soon confer with President Hoover on business conditions.

Fenton B. Turck Jr., vice president, American Radiator Co., New York, has been appointed chairman of a permanent committee of the National Business Survey conference to encourage building activities in support of President Hoover's business stability program.

B. Schneider was elected president of the Harmony Foundry Co., Belleville, Ill., at a recent meeting of the board of directors. E. Wiechert was named vice president, Frank Schroer secretary, Frank Schaefer treasurer, and William Kaoesberg general manager of the Harmony Co.

William B. Prosser has been appointed general manager of the Perfect Circle Co., Tipton, Ind.; Thomas Bolton is factory superintendent and J. E. Prifogle has been appointed his assistant. The changes were announced following the transfer of William Kramer to the Hagerstown, Ind., plant.

Robert E. Masters, for many years a prominent foundryman and a contributor to THE FOUNDRY, celebrated his eighty-first birthday last Christmas.

ROBERT E. MASTERS

Mr. Masters was born in 1848 in New York. When he was 18 years old, he became an apprentice in a prominent foundry in New York. When he had completed his course, he worked for various companies in the East and Midwest, where he held many responsible positions. About 10 years after his graduation into the class of all-around foundrymen, he accepted a position as manager of the foundry of the Tredegar Iron Works, Richmond, Va. The remainder of his foundry career was spent in the South and Southwest as manager of various foundries and as consultant. Prior to his retirement from the foundry field about 10 years ago, Mr. Masters was general manager of the Marshall Foundry, Houston, Tex.

Harry Davisson, engaged in foundry and machine shop work for the past 19 years, and owner and operator

for nine years past of the Davisson Machine Shop, Shelbyville, Ind., has been appointed manager of the Decatur Foundry & Machine Co., Greensburg, Ind., to succeed George Bowman, who has retired.

Albert C. Bruce, formerly chairman of the board of directors, U. S. Hoffman Machinery Corp., Chicago, has been elected president to succeed Herbert W. Stone, resigned. George E. Bowdoin was elected vice president and Wayne Mendell, general sales manager, was elected vice president in charge of sales.

C. F. Gallmeyer, formerly connected with the Kendallville Foundry Co., Kendallville, Ind., has resigned to accept a position as foundry superintendent of Layne & Bowler, Inc., Memphis, Tenn. Prior to his association with the Kendallville company, he was connected with the Montpelier Foundry & Machine Co., Montpelier, Ind., Nelson Bros. Co., Saginaw, Mich. and the Indianapolis Castings Co., Indianapolis.

M. L. Spackman has resigned his position as secretary and foundry manager of the Henry Furnace & Foundry Co., Cleveland. He had been connected with that firm for 20 years. Mr. Spackman began his career with the Henry company as time keeper at the Chagrin Falls, O., plant. He was transferred to the Medina, O. plant as office manager in 1913 and in 1916 was transferred to Cleveland. He was appointed foundry manager in 1920.

George T. Rosselle, manager of the Tiffin, O., plant, Webster Mfg. Co., Chicago, engineer, founder and machinist, recently was elected a vice president and has been transferred to the Chicago office. Merton W. Myers, office manager at Tiffin, was appointed manager to succeed Mr. Rosselle. Other officers elected include: A. T. Perkins, president; Mr. Rosselle, F. C. Harper and D. P. McPherson, vice presidents; Charles Clarke, secretary-treasurer; H. E. Byrne, assistant secretary. Ralph D. Sneath and William H. Kilbow, Tiffin, and John Kiskadden, Detroit, were elected members of the executive board.

Charles J. Miller was re-elected president of the Fremont Foundry Co., Fremont, O., and J. L. Dryden, Detroit, was elected vice president at a recent meeting of the board of directors of that company. Other officers include A. J. Kroenke, Cleveland, treasurer and L. W. Allen, Detroit, secretary. The board of directors include C. J. Miller, J. L. Dryden, A. J. Kroenke, William Christian, and George H. Klein, Detroit, A. C. Orth, and J. R. Krause, Cleveland and George H. Engler, Fremont.

L. B. Davis has been made secretary of the Perfect Circle Co., Hagerstown, Ind., to succeed L. S. Bowman, who has become secretary of the Indiana board of tax commissioners.

John D. Capron, whose recent election as president of the Glamorgan Pipe & Foundry Co., Lynchburg, Va., was announced in the Feb. 1. issue of THE FOUNDRY is a well-known figure in the cast iron pipe industry. Mr. Capron was graduated from Sheffield Scientific school of Yale university in 1914 as a mechanical engineer. After a year of graduate work during

JOHN D. CAPRON

which he acted as assistant instructor on the strength of materials, he joined the United States Pipe & Foundry Co. For several years he was located at this company's Anniston, Ala., plant, and filled various positions there. During the World war he was a member of the air service. In 1919 he rejoined the United States Pipe & Foundry Co. as a member of the Chicago sales force. After two years he was transferred to the general office at Burlington, N. J., and since 1921 he acted as publicity manager, research engineer and statistical engineer. He left this connection on Jan. 1, 1930, to become president of the Glamorgan Pipe & Foundry Co. Mr. Capron is a member of the American Iron and Steel Institute and associate member of the American Society of Mechanical Engineers and is an active member of the American and New England Water Works associations.

Ernest Lancashire, formerly connected with the American Steel Foundries, Chicago, at the Granite City, Ill., plant, has been transferred to the wheel department at the Alliance, O. works. Mr. Lancashire is a former member of the faculty of the University of Illinois. He received his education in England and served in various capacities with the Brown-Firth Research Laboratories, Sheffield, and the Newcastle Alloy Co., Newcastle-on-Tyne, England. He came to America in 1923 and was employed by the American Steel Foundries as research chemist. Later he served for two years as metallurgist, Standard Brake Shoe & Foundry Co., Pine Bluff, Ark. He then joined the faculty of the University of Illinois, Urbana, Ill. He resigned this position to become affiliated with the American Steel Foundries in 1929.

J. H. Johnson, formerly general foundry foreman of the Cleveland plant, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been appointed foundry superintendent at that plant. Mr. Johnson was born July 11, 1895 at Cannonsburg, Pa., and received his early education in the schools of that city. He entered Westminster college from which he was graduated with an A. B. degree in 1916. Prior to his association with the Westinghouse company Mr. Johnson was connected with the American Steel & Wire Co., Donora, Pa. He became associated with the Westinghouse company in 1920 at the East Pittsburgh plant where he served under the late Jesse L. Jones. He was transferred to Cleveland in 1922 as foundry metallurgist and on May 1, 1925 was appointed general foundry foreman. He occupied this position until his recent promotion.

Belgian Foundrymen Will Hold Convention

The foundry convention which will be held at Liege, Belgium, from June 22 to 28 will be important. It will be held in conjunction with an international congress of mines, metallurgy and applied geology on the occasion of the centenary celebration of the independence of Belgium. In conjunction with this event an exhibition will be held with sections in Liege, Brussels and Antwerp. The leading foundry associations of Europe will take part in the convention, and the whole proceedings have been placed under the patronage of the King of Belgium and the Belgian government.

The metallurgical section of the international congress will be divided into subdivisions under the following headings: blast furnaces; steel and ferroalloys; foundry; nonferrous metals; nonferrous alloys; fuel. The Association Technique de Fonderie of Belgium has been entrusted with the organization of the foundry section.

A feature of the convention will be an organized visit to the exhibition, particularly that section pertaining to foundries. There also will be visits to the most important iron and steel works of Belgium, and possibly of Luxemburg, including the principal industrial laboratories.

Obituary

Edward Loder Whittemore, chairman of the board of directors, National Malleable & Steel Castings Co., Cleveland died at his home in Cleveland Heights, O., Jan. 29. Mr. Whittemore commenced his business career in the office of the Bridgeport Malleable Iron Co., Bridgeport, Conn. He remained with that company for about 5 years. In 1887 he was elected secretary and treasurer of the Indianapolis Malleable Iron Co., Indianapolis. He became manager of the Toledo Malleable Iron Co., Toledo, O., in 1890 and for a time had charge of both the Indianapolis and the Toledo plants. When the National Malleable Castings Co. was organized in 1891 by a merger of the Cleveland, Chicago, Indianapolis and Toledo Malleable Iron companies, Mr. Whittemore was elected a director and vice president. He became chairman of the board in 1913 which position he retained until his recent death. Mr. Whittemore was born in Rye, N. Y. on Sept. 12, 1861. He received his education at Adelphi academy and the Polytechnic institute, Brooklyn, N. Y. Later he entered Sheffield Scientific school, Yale university, and was graduated in 1879. In addition to his connection with the Malleable company, Mr. Whittemore was a director of the Interlake Iron Corp., Chicago; Eastern Malleable Iron Co., Naugatuck, Conn., and Parsons & Whittemore, Inc., N. Y. He also was a member of many clubs and was interested in several civic enterprises.

George T. Honstain, chairman of the board, Western Crucible Steel Casting Co., Minneapolis, died Jan. 16.

P. L. Sowersby, 47 years old, Cleveland manager, Crane Co., Chicago, died of pneumonia at his home in Cleveland, Jan. 29 after a two weeks' illness.

John Olle, president of the Racine Brass & Iron Co., Racine, Wis., died Jan. 28. He was 59 years old and established the foundry in association with John Tooman in 1900.

Frank J. Brittingham 46 years old, Pittsburgh district manager, Cleveland Crane & Engineering Co., Wickliffe, O., died Jan. 27 at Pittsburgh. He was a graduate of Purdue university and had been Pittsburgh manager for the Cleveland company since 1911.

Clarence W. Hodges, 53, of Ridgewood, N. J., purchasing agent, Worthington Pump & Machinery Corp., New York, died Jan. 17 at Paterson, N. J. He was born at Randolph, Vt., in 1876 and was graduated from Williams college in 1900. Prior to his Worthington connection he was material supervisor for the American Locomotive Co.

Francis Cole Pratt, formerly vice president and chairman of the manufacturing committee, General Electric Co., Schenectady, N. Y., died Jan. 26

EDWARD L. WHITTEMORE

in New York after an illness of six weeks. Prior to his connection with the General Electric Co., he was vice president of the Pratt & Whitney Co., Hartford, Conn., of which his father was one of the founders. He joined the General Electric company in 1906.

Thomas Shipley, 69, president, York Ice Machinery Corp., York, Pa., died Jan. 22, at York, Pa. Mr. Shipley was born in Jersey City, N. J., June 30, 1861 and received his education at Cooper institute, New York. Upon graduation, he became associated with Morris & Cummings Dredging Co., Jersey City. In 1884, he organized Wood & Shipley for the manufacture of ice machinery. In 1886 he became associated with the Frick Co., Waynesboro, Pa., manufacturer of farm and ice machinery and in 1897 he joined the York Mfg. Co., as general manager. That concern was merged with other manufacturers of ice machinery in 1927 and Mr. Shipley became president and general manager. He was interested in many trade associations in the industry and was an active member of the American Society of Refrigerating Engineers.

Warren Phelps King, vice president, Aluminum Co. of America, whose recent death in Sarasota, Fla. was announced in the Feb. 1 issue of THE FOUNDRY, was born in Ithaca, N. Y., on Sept. 9, 1865. He attended Cornell university and was graduated in 1888. His first business connection was with the Lehigh Valley Coal Co., Buffalo. Later he became associated with the New York Car Wheel Co., Buffalo, as assistant to the president. He purchased an interest in the Brooks Bros. Brass Foundry Co., Buffalo, in 1907. Later this company was reorganized as the Liberty Brass Foundry Co., and he became president. In 1910, the Liberty Brass Foundry Co. and the Allyne Brass Foundry Co., merged to form the Aluminum Castings Co. which later became the Aluminum Manufactures, Inc., and Mr. King served as vice president and finally as president. Mr. King was one of the pioneers in the development of the permanent mold process for casting aluminum. At the time of his death, Mr. King was a vice president of the Aluminum Co. of America, president of the Aluminum Manufactures, Inc., and a director of several other companies.

Publishes Interesting Book on Refractories

Harbison-Walker Refractories Co., Pittsburgh, has published an interesting book on its facilities and products entitled, "Modern Refractory Practice." The book is beautifully executed and contains much valuable information on the line of refractories manufactured by the company. The first section is devoted to descriptions of the facilities of the company for the production of fire clay brick. It also describes brick sizes and illustrates them on several pages. Specifications and general information on that class of refractories also are included. The second section contains information on high alumina refractories and the next chapter is devoted to silica brick. The following chapters contain information about magnesite and chrome refractories, special clays, high temperature cements, and acid proof brick and tile. The following chapter is devoted to information an the export department of the company. Other chapters are headed, application of refractories in furnace construction, tables useful in the application of refractories, for-

mulae for calculating brick work, and general information. An index of the material found in the volume also is provided.

Handles Equipment Sales

James C. Morgan, for the past 10 years associated with the Yale & Towne Mfg. Co., Stamford, Conn., has been appointed to take charge of all material handling equipment sales. Mr. Morgan formerly was connected with the C. W. Hunt Co., West New Brighton, Staten Island, New York.

He will assume some of the duties formerly assigned to E. C. Waldvogel, vice president in charge of sales who will retire from active participation in

JAMES C. MORGAN

the company on April 1. Mr. Waldvogel will remain a director. He has been associated with the Yale & Towne Mfg. Co., for the past 25 years.

Walter B. Dodge, formerly assistant to the vice president in charge of sales, has been appointed manager of hardware sales. He has been connected with the company for the past 24 years.

Ceramists Will Meet

The thirty-second annual meeting of the American Ceramic society and the American Refractories institute will be held at the Royal York hotel, Toronto, Ont., from Feb. 16 to 21. In addition to a general session, technical sessions of the seven industrial divisions of the two organizations will be held. Papers of interest to foundrymen which will be presented during the sessions include, "Blistering Phenomena in the Enameling of Cast Iron," by A. I. Krynitsky, bureau of standards, Washington; "Acid Resisting White Dry Process Cast Iron Enameling," by A. I. Andrews, University of Illinois, Urbana, Ill.; "Results Obtained During a Study of Foundry Practices," by W. Bogenschutz and H. G. Wolfram, Porcelain Enamel & Mfg. Co., Baltimore; "Modern Sandblasting," by C. Boultman, Pangborn Corp., Hagerstown, Md.; "Refractories and Refractory Cements for the Nonferrous Foundry," by H. E. White, Lava Crucible Co., Pittsburgh, and "Service Data on Linings for Gray Iron Cupolas," by C. E. Grigsby, Evens & Howard Fire Brick Co., St. Louis. A. J. Tuscany, manager of the Gray Iron institute, Terminal Tower building, Cleveland, will present a paper on "Important Developments in the Gray Iron Industry."

The general secretary of the American Ceramic society is R. C. Purdy, Columbus, O., and the secretary of the American Refractories institute is Dorothy A. Texter, Pittsburgh.

Issues Catalog on Uses of Nickel Cast Iron

The International Nickel Co. Inc., 67 Wall street, New York, has issued a catalog on the uses of nickel cast iron. Much of the information already has appeared in advertisements in various publications including THE FOUNDRY. It has been compiled as a reference booklet for the convenience of foundrymen interested in the use of nickel and chromium in iron mixtures. The booklet is divided into six sections headed as follows: automotive, aeronautical, general machinery, machine tool, power and instructions.

At the beginning of each section, the castings producers, users, applications and improvements in their properties are listed. Additional information of interest to foundrymen also is given.

Nominate A. F. A. Officers and Directors

At a meeting of the nominating committee of the American Foundrymen's association, held recently in Cleveland, the following officers and directors were nominated: For president, to serve one eyar—N. K. B. Patch, secretary, Lumen Bearing Co., Buffalo; for vice president, to serve one year—E. H. Ballard, general foundry and pattern shop superintendent, General Electric Co., West Lynn, Mass.; for directors, each to serve three years—C. S. Anderson, vice president and general manager, Belle City Malleable Iron Co., Racine, Wis.; H. R. Culling, vice president, Carondolet Foundry Co., St. Louis; Fred Erb, president, Erb-Joyce Foundry Co., Detroit; R. M. Maull, treasurer, Tabor Mfg. Co., Philadelphia, and D. M. Scott, vice president, Gould Coupler Co., Depew, N. Y., and Symington Co., Rochester, N. Y. The nominating committee included Past Presidents A. B. Root Jr., chairman; S. W. Utley and S. T. Johnson; and members elected, T. H. Addie, R. J. Doty and W. J. Grede.

Appointed Vice President

Carl F. Mayer, for the past 10 years manager of the oven department, Swartwout Co., Cleveland, recently

CARL F. MAYER

acquired by the Foundry Equipment Co., Cleveland, has been elected second vice president of the latter company. Mr. Mayer is a native of Cleveland having been born there in 1896. He received his preliminary education in the public schools of that city and later entered the University of Michigan from which he was graduated with a bachelor of science degree in marine engineering. Mr. Mayer spent one year after graduation with the Emergency Fleet Corp., in marine work and then accepted a position in the engineering department of the Ohio Body & Blower Co., Cleveland. In 1922 when the Swartwout Co. was organized, Mr. Mayer was appointed manager of the oven department. He continued in that capacity until that division of the company was taken over by the Foundry Equipment Co. Mr. Mayer is a member of the American Foundrymen's association and presented a paper on core oven design and performance at the 1922 convention of the society.

Trade Trends in Tabloid

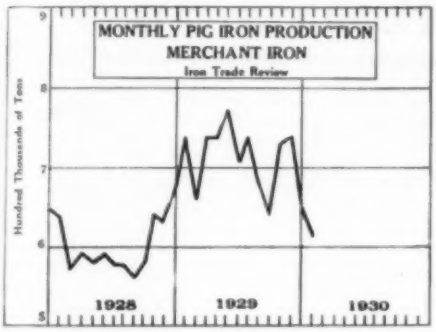
STEEL foundries lead the list with reports of improved inquiries, satisfactory operations and better business in prospect. Many jobbing steel foundries report backlog orders and present operating rates ahead of any similar period for several years. Average rate of operation for December was 87 per cent according to the department of commerce.

—T—T—

Shipments, orders and stocks of enameled sanitary ware declined in December, but were closely comparable with the totals for December, 1928.

—T—T—

Freight car loadings during January were slightly below the totals of the



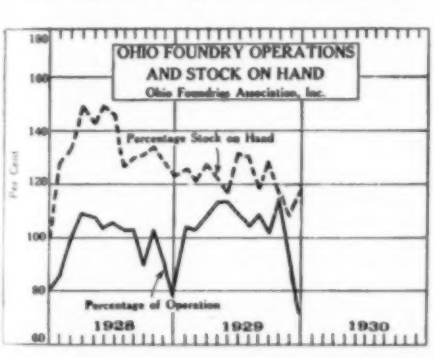
same month the preceding year. Railway car orders and inquiries strengthened during the last half of January and sizeable orders were noted during the week of Feb. 3. The Van Sweringen interests placed 11,350 cars and the Erie 2150 cars in that week.

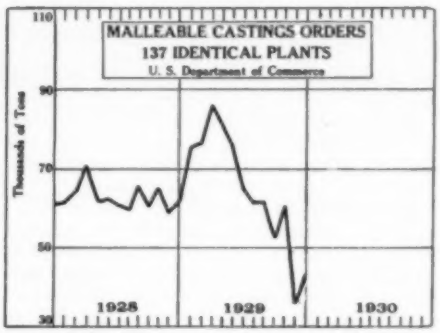
—T—T—

Increasing sales of merchant pig iron in the Chicago district evidence improved foundry outlook. Gray iron foundries are operating at about 75 per cent of capacity. Steel foundries are busy while a pickup is noted in malleable operations with larger shipments to the automotive industry.

—T—T—

January automotive figures will be below the 1929 level according to early reports. Buick shipped 7299 cars this year, against 13,008 in January last





year. Ford's production of cars and trucks in January is stated to be 34 per cent below 1929.

—T—T—

Gray Iron Institute, Inc., Cleveland, notes from the reports of 102 gray iron foundries, 11 believe the outlook good, 58 fair, 30 poor and 3 bad.

—T—T—

Manufacturers of engineering specialties, tools and hardware report early January behind the same period of 1929.

—T—T—

Steel mill operations have improved slightly compared with the closing weeks of the last year. Mid-January schedules were 65 per cent of capacity, compared with about 59 per cent for the month of December.

—T—T—

Price trends are giving concern in a number of industries, Shading of

RAW MATERIAL PRICES
Feb. 7, 1930

Iron	
No. 2 foundry, Valley	$18.50
No. 2 Southern, Birmingham	15.00
No. 2 foundry, Chicago	20.00
No. 2 foundry, Philadelphia	20.76 to 21.26
No. 2 foundry, Buffalo	18.50
Basic, Valley	18.50
Basic, Buffalo	18.00
Malleable, Chicago	20.00
Malleable, Buffalo	19.00
Coke	
Connellsville beehive coke	$3.50 to 4.85
Wise county beehive coke	4.25 to 5.00
Detroit by-product coke	9.00
Scrap	
Heavy melting steel, Valley	$16.00 to 16.50
Heavy melting steel, Pitts.	16.50 to 17.00
Heavy melting steel, Chicago	13.00 to 13.50
Stove plate, Buffalo	12.50 to 12.75
Stove plate, Chicago	10.75 to 11.25
No. 1 cast, New York	10.85
No. 1 cast, Chicago	13.50 to 14.00
No. 1 cast, Philadelphia	15.50 to 16.00
No. 1 cast, Pittsburgh	14.50 to 15.00
No. 1 cast, Birmingham	13.00 to 14.00
Car wheels, iron, Pittsburgh	15.00 to 15.50
Car wheels, iron, Chicago	14.00 to 14.50
Railroad malleable, Chicago	16.50 to 17.00
Agricultural mal., Chicago	13.75 to 14.25
Malleable, Buffalo	17.00 to 17.50
Nonferrous Metals	**Cents per pound**
Casting, copper, refinery	17.12½
Electro, copper, producers	18.00
Straits, tin	39.12½
Lead, New York	6.25
Antimony, New York	8.75
Nickel, electro	35.00
Aluminum, No. 12, producers	23.00
Aluminum, No. 12, remelt	16.25 to 16.75
Zinc, East St. Louis, Ill.	5.25

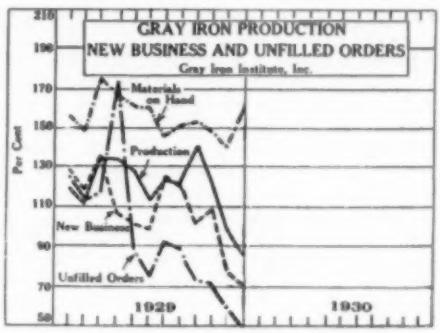
steel prices has led to a strong reaction. Similarly pressure on castings prices is noted, but is meeting with strong resistance by jobbing interests.

—T—T—

Pig iron output for January registered the first gain since May, 1929, according to *Iron Trade Review*. Total production is given as 2,838,543 tons, but the daily average rate is 91,565 tons, compared with 91,513 tons for December. Merchant iron registered 610,238 tons in January as compared with 661,343 tons for December, 1929.

—T—T—

Revenue freight car loadings for the first four weeks of 1930 were 7 per cent under the totals for the



same period in 1928, although an increase is noted in the last week of January, which is carrying over into early February.

—T-T—

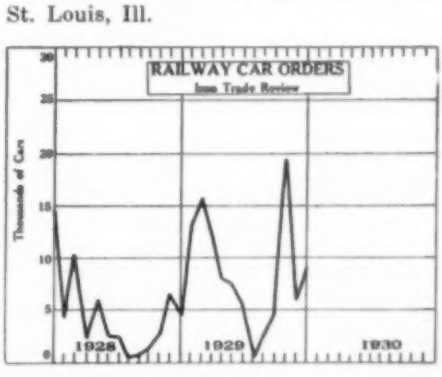
Confidence in improved conditions was expressed by those attending the Ohio Foundries Association Inc. meeting in Dayton, Feb. 6.

—T-T—

Buckeye Steel Castings Co., Columbus, O., reported earnings in the past year more than double those of 1928.

—T—T—

Average New York prices on nonferrous metals during January, according to *Daily Metal Trade*, follow: Casting copper, 17.045c; electrolytic copper, 18.00c; Straits tin, 38.865c; lead, 6.250c; antimony, 8.614c; aluminum, 23.90c. Zinc averaged 5.242c, E. St. Louis, Ill.



What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

North Attleboro Foundry Co., North Attleboro, Mass., recently was damaged by fire.

Belleville Stove & Range Co., Belleville, Ill., recently suffered $30,000 damage to its warehouse and office building by fire.

American Foundries, Inc., Indianapolis, was practically destroyed by fire on Jan. 25. Damage is estimated at $900,000. The company has tentative plans for reconstruction.

Enterprise Foundry, William street, Albert Lea, Minn., will repair damage to plant recently caused by fire.

International Harvester Co., care W. B. Swift, 606 South Michigan avenue, Chicago, contemplates a foundry on Park street, Milwaukee, although date is indefinite.

Mackintosh-Hemphill Co., Midland, Pa., maker of heavy machinery, Twelfth and Etna streets, Pittsburgh, plans extensions and improvement to its plant to cost about $85,000.

Egyptian Foundry & Mfg. Co., Belleville, Ill., has been incorporated with $25,000 capital by Edward A. Ruff, 500 West Main street, to operate a foundry.

G. H. Smith Steel Casting Co., Milwaukee, is having preliminary plans prepared for a plant at Chase and Holt avenues. W. Stiemke, 500 Clinton street, is in charge.

B. F. Hoffstetter, 314 West Twelfth street, Erie, Pa., owner of the Odin Stove Mfg. Co., contemplates foundry alterations and additions for the spring.

Sandwich Foundry Co., Sandwich, Ont., recently damaged by fire, has awarded reconstruction contracts. New machinery and tools will be purchased. (Noted Jan. 15.)

Frontier Bronze Corp., 818 Elmwood avenue, Niagara Falls, N. Y., manufacturer of castings, have plans for a plant addition. J. M. Brown is owner.

Buckeye Foundry Co., formerly at 2257 Buck street, Cincinnati, has acquired a three and a half acre site for plant building on Beekman street, Fairmount.

R. S. Holland, 496 Twenty-third avenue, Ft. Wayne, Ind., is organizing a company to establish a plant for the production of brass, bronze and aluminum castings. (Noted Dec. 1.)

The foundry plant of the Owens-Illinois Glass Co., Toledo, O., has been acquired by the Kinite Corp., Milwaukee, under an agreement whereby the latter will make castings for the three Owens-Illinois plants in West Virginia.

Acme Iron & Bronze Foundry, 737 West Fourth South street, Salt Lake City, Utah, recently has opened its new foundry. It is equipped to make gray iron, bronze, brass, aluminum and copper castings.

Calgary Iron & Foundry Ltd., Calgary, Alta., has been incorporated with $300,000 by Carlton C. Cook and William H. McLaws, to manufacture and deal in iron, brass, steel and other metals.

Crucible Steel Castings Co., Eighty-fourth street and Almira avenue, Cleveland, is receiving bids on the general contract for a foundry and storage building. G. S. Rider, Marshall building, is engineer and architect.

Arkansas Foundry Co., Little Rock, Ark., has plans for a $75,000 building and equipment program. Two new buildings and an extension to another are under consideration. The equipment required includes a 60-foot, 10-ton traveling crane.

The United States Pipe & Foundry Co., Burlington, N. J., has awarded a contract for the erection of a 3-story addition, 30 x 60 feet, to its present general office building. The addition will house offices and the general control physical and chemical laboratories.

Riverside Foundry & Machine Works, Palatka, Fla., recently incorporated, has started production and is carrying on a general jobbing business. Ferrous and nonferrous castings are being made and general machine repairing is done. M. Drennan and T. B. Gillespie are owners. (Noted Dec. 1.)

Lincoln Foundry & Mfg. Co., Mt. Carmel, Ill., expects to have its new plant in production by March 1. The firm is moving its entire organization from Belleville, Ill. An enameling plant is being added to the gray iron foundry, for use in connection with the production of stoves. The company will also do a general foundry jobbing business. E. H. Ehert is general manager.

Axelson Machine Co., Los Angeles, manufacturer of oilfield equipment, which has operated under this name for 38 years, has changed its name to Axelson Mfg. Co. Ltd. No other change will be made, the personnel and policy remaining the same. Jule C. Axelson is president; Delbert F. Axelson, vice president and general manager; Clyde Ellwood, vice president and sales director, and Everett Kerfoot, secretary-treasurer.

New Trade Publications

REFRACTORIES — North American Refractories Co., Cleveland, has issued a folder describing its plant and facilities.

LADLES—Whiting Corp., Harvey, Ill., has issued a folder on its helical-worm geared ladles. The advantages and details of construction are discussed.

STARTERS—Electric Controller & Mfg. Co., Cleveland, in a current, illustrated folder, describes and shows the uses of its automatic synchronous motor starters.

BEDPLATES—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has published an 8-page booklet on its bedplates for Westinghouse-Nuttall speed reducers. The bulletin describes the bedplates with and without outboard bearings and contains drawings and tables giving their dimensions.

STEEL CASTINGS—Farrell-Cheek Steel Foundry Co., Sandusky, O., recently has issued a 13-page folder on its special steel for castings designed to resist shock, wear, impact and abrasion.

CHEMICALS—Merck & Co., Rahway, N. J., is circulating a catalog listing the various laboratory chemicals that it manufactures. The materials are indexed alphabetically with the price and analysis.

PLATING—The New Jersey Zinc Co., New York, has published a 12-page bulletin giving information on the plating of zinc base die castings and rolled zinc. The data includes polishing, cleaning, acid dipping, plating, etc.

SWITCHES—General Electric Co., Schenectady, N. Y., has issued two folders on switches. One describes enclosed, magnetic switches for alternating current motors and the other three phase, enclosed, magnetic, reversing switches for alternating current.

CASTINGS — Gray Iron institute, Terminal Tower building, Cleveland, recently has published a folder entitled, "Pointing the Way to Better Castings." The text deals with the value of good patterns in the production of high grade castings.

ELEVATOR DRIVES—H. W. Calwell & Son Co., Chicago, a subsidiary of the Link-Belt Co., has issued a 23-page folder on its new type drive for bucket elevators. The folder describes the drive in detail and cites its advantages. Specifications, sprocket ratio charts and layout drawings are included in the booklet.

SAND—Enterprise Sand Co., Fulton building, Pittsburgh, in a current folder describes the various sands that it markets. Screen and chemical analyses of different sands are given. The company mines, blends and sells sands used in the manufacture of malleable, gray iron, steel and nonferrous castings.

MOTOR GENERATORS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has issued a folder which describes and illustrates its synchronous motor generators. Another folder by the same company describes and illustrates its engine-driven, alternating-current, synchronous generators.

FURNACES — Penicud & Co., Bagnolet, France, has issued a 22 page catalog describing the various types of furnaces that it manufactures. The furnaces are oil or coke-fired for melting metals in crucibles or iron pots. Features of construction of the furnaces are shown diagammatically.

ELECTRIC HEAT—Public Service Co. of Northern Illinois, 72 West Adams street, Chicago, has released a booklet entitled "Electric Heat for Industry." The folder tells the advantages of electric heat and is exceptionally well illustrated with reproductions from photographs of typical installations showing the varied uses of that kind of heat.

FLOODLIGHTING PROJECTORS — General Electric Co., Schenectady, N. Y., has published a booklet on its floodlighting equipment. It gives the applications, advantages and describes the different types of equipment that the company makes. The pamphlet is illustrated generously with reproductions from photographs of lighting effects on different buildings.

ELECTRIC TOOLS—Black & Decker Mfg. Co., Towson, Md., has published a catalog of the various products that the company manufactures. The products listed in the catalog include electric drills, of many types, both portable and stationary, and accessories; portable electric hammers; portable sanders; saws; electric grinders; wire wheel brushes; grinding wheels; bench type grinders; valve refacers and accessories; and its line of heavy duty electric grinders. Specifications and descriptions accompany the various products.

ARC-WELDING—General Electric Co., Schenectady, N. Y., has issued a folder on atomic-hydrogen, arc-welding equipment. The folder explains the process, gives a list of equipment and explains its operation. A diagram shows the layout of the equipment and charts gives data on the process. A picture of an electrode holder and an illustration showing a specimen of this type of welding also are given.